National Sports Academy "Vassil Levski"
Sofia, Bulgaria

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2–3 December 2022

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Volume 1

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VOLUME 1

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SPORTS AND HEALTH

HIGH ALTITUDE TRAINING FOR YOUNG SWIMMERS – A PILOT STUDY ON THE HEMATOLOGICAL INDICATORS

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ABSTRACT
Background. One of the most expected benefits of hypoxia and altitude training is improvement of blood counts. This study is focused on the effects of a high-altitude training camp at 2048 m above sea level on changes in the blood morphology of young swimmers.
Study Design and Subject. Six young swimmers (male and female) took part in the study as part of their annual training program. The athletes lived and trained at the same altitude according to the principle "live high and train high". The goals of the camp were to introduce the young swimmers to the upcoming cycle after a 15-days summer break. The main task was to build a solid basis in the low aerobic zones so that we could build on them later focus on the swimmers' technique in each exercise. The training camp lasted 21 days, and the number of sessions were 30. The following blood indicator were taken three times (before, after, and one month later): Leukocytes, Erythrocytes, Haemoglobin, Haematocrit, Thrombocytes, Neutrophils, Lymphocytes, Monocytes, Eosinophils, Basophils, and Iron. Descriptive statistics and ANOVA were applied for the statistical processing of the data.
Results. The results showed that there were no statistically significant differences between the measurements. Only for the indicator – thrombocytes, the difference between the groups was statistically significant – F= 4,587 and α=.028 and within the groups between before altitude training camp and after 21 days of living and training in altitude conditions (α=.025).
Conclusions. After a 21-day training camp, the levels of haematological indicators change but are not statistically significant. This may be due to the fact that at a young age, the role of high-altitude training is still disputable. The dynamics of the data one month after the descent from the mountain and the decrease in the values for most indicators are interesting. This fact raises the question of the duration of the effect in young swimmers after taking part in a high-altitude camp.

Keywords: *red blood cell, hemoglobin, swimming, training camp, thrombocytes*

INTRODUCTION

One of the most expected benefits of hypoxia and altitude training is the improvement of the hematological variables. Exposure to a terrestrial or simulated hypoxic environment leads to a reduction in the PaO2 as well as in arterial oxygen saturation (SaO2) (Rusko et al., 2004).

The exposure to hypoxia induces an increase in EPO production by the kidneys, which in turn accelerates erythropoiesis.
Chapman et al. (1998) reported individual variability in the altitude-induced erythropoietic response ranging from 8.0 to 37.5 mU/ml at 2,500 m, with further dependency upon exposure time. Previous studies have shown that the EPO level increase and erythropoiesis acceleration depend on the "hypoxic dose." Both levels and duration of hypoxic exposure can influence the hematological response to altitude training. Likewise, Rusko et al. (2004) suggested that the minimum time to reach an acclimatization effect and improve blood oxygen-carrying capacity appears to be >12 h per day for at least three weeks at an altitude of 2,100 to 2,500 m. Wilber et al. (2007) argued that the altitude of 2,000 to 2,500 m is sufficient if the daily dose of hypoxic exposure is higher than 22 h for a minimum of 4 weeks. Fewer hours (12–16 h) may also be used, but exposure to a higher altitude (2,500 to 3,000 m) is necessary to reproduce the erythropoietic effects.

Some studies also show that an altitude <2,000 m may be ineffective for improving hematological variables. However, the data presented by Chapman et al. (2014) and Nadarajan et al. (2010) indicate that it is possible to improve RCV or %Ret after training performed at an altitude below 2,000 m. Other studies support these observations. Furthermore, Frese and Friedmann-Bette (2010) carried out an experiment in which two training camps were held at altitudes of 1,300 and 1,650 m (LH-TH), separated by training at sea level. They reported a non-significant increase in tHbmass after the first three weeks of altitude training, but after the second training, camp tHbmass increased by 5.1% compared to the pre-test values. In this experiment,

the cumulative time at altitude was ~1,000 h and perhaps compensated for the lower altitude to elicit a hematological response.
These observations indicate that the total dose of hypoxia resulting from the combination of altitude and time of exposure seems to determine the hematological response to altitude training.
In swimming, altitude training is most often used in the transition period or the first half of the preparatory period, lasting 20-25 days. In cases where competitions are planned at 500-1500 m above sea level until the days of the competition.

The dynamics of adaptive changes in altitude conditions go through three main stages: acute acclimatization - 4-6 days, during which stage there are immediate functional adaptive changes in the body under the influence of altitude and climatic conditions and means of training; second transitional stage to actual adaptation - 5-8 days, with increasing parameters of training effects and third - of actual adaptation - after 15 days stay in altitude conditions, characterized by high parameters of training effects, both intensity, and duration. The emphasis is on specialized exercises.
The re-adaptation phase takes place in waves, the most delicate being the period between the sixth and ninth day after the descent from the mountain and the increase in working capacity to 3-5 days after this period. The most noticeable improvement in functional parameters was observed two weeks after altitude bearing.

An important, or even essential, role in swimming, irrespective of the distance, is played by the athlete's endurance, relying on their physical capacity. However, in races longer than 100 meters, it is aerobic metabolism that predominates in providing the muscles with the energy needed for contractions. Hence, to improve the physical fitness of the organism, it is necessary to start the training early enough before a major competition so that the mean erythrocyte volume and hemoglobin mass (both responsible for oxygen transport), as well as the number of mitochondria and the amount of myoglobin in the muscles, are elevated in a timely fashion.

The present study aimed to determine the effects of a high-altitude training camp at 2048 m above sea level on changes in blood morphology, and answers to the following question were sought: What hematological changes are evoked in the examined young swimmers by the high-altitude training?

METHODS

Subjects

Six young swimmers (males and females) born in 2009-2011 took part in the study as a part of their annual training program. Each athlete signed an informed consent form before participating in the study. In addition, all subjects and their parents were informed in advance about the study procedures and asked to sign a consent term according to the Declaration of Helsinki.

Study Design

The swimmers attended the high-altitude training camp in Belmeken - Bulgaria, set at about 2048 m above sea level. According to the principle "live high and train high" (LHTH), the athletes lived and trained at the same altitude. The camp's goals were to introduce the young swimmers to the upcoming cycle after a 15-day summer break. The main task was to build a solid base in the low aerobic zones so that we could build on them later and focus on the swimmer's technique in each exercise. The training camp lasted 21 days, and the number of sessions was 30. All training was in the following sequence: 2 days, they did two training sessions, one day one-time. For the whole period of the camp, we climbed three times. In addition, we made regular walks for about an hour. Furthermore, they did 3-4 workouts for OFP, concentrating on core, general strength, or specific strength. Throughout the camp, the children followed a strict diet and sleep - including an afternoon sleep.

Before and after participation in the training camp and one-month letter estimations of the Leukocytes, Erythrocytes, Haemoglobin, Haematocrit, Thrombocytes, Neutrophils, Lymphocytes, Monocytes, Eosinophils, Basophils, and Iron levels were performed.
All training was in the following sequence: 2 days - two training sessions, one day, one time. For the whole period of the camp, they climbed three times in addition. In addition, they made regular walks for about an hour. Each week they did 3-4 workouts for OFP, concentrating on core, general, or specific strength. Throughout the camp, the children followed a strict diet and sleep - including an afternoon nap.

Descriptive statistics and the analysis of the differences in means of study variables were evaluated

using one-way ANOVA. Levene's test was used to assess the homogeneity of variance. Those variables with a p-value of <0.05, at a 95% confidence interval (CI), were considered statistically significant. The result of males and females were summarized.

RESULTS AND ANALYSIS

Table 1 shows the values of the hematological parameters for three-time measuring. Comparison of Leukocytes, Erythrocytes, Haemoglobin, Haematocrit, Thrombocytes, Neutrophils, Lymphocytes, Monocytes, Eosinophils, and Basophils between three measurements are presented in Table 2; Hgb_{mass} is presented in Figure 1 and erythrocytes in Figure 2. There were no significant differences in the mean only for the thrombocyte ($p < .05$) shown in Figure 3.

Table 1. *Mean level and standard deviation of the hematological parameters*

Variables		Mean	S	Min	Max
Leukocytes	1	5.32	0.70	4.13	5.91
	2	6.02	2.43	4.1	10.8
	3	5.52	1.01	4.1	6.9
	Total	5.62	1.51	4.1	10.8
Erythrocytes	1	4.74	0.27	4.39	5.09
	2	4.94	0.17	4.63	5.12
	3	4.87	0.20	4.68	5.25
	Total	4.85	0.22	4.39	5.25
Haemoglobin	1	134.5	6.41	126	142
	2	140.83	7.28	131	151
	3	139	6.19	132	148
	Total	138.11	6.81	126	151
Haematocrit	1	13.56	20.41	0.37	41
	2	13.70	20.56	0.41	40.7
	3	14.44	21.76	0.39	44.3
	Total	13.90	19.65	0.37	44.3
Thrombocytes	1	292	56.19	234	376
	2	220	36.51	168	258
	3	241.66	29.37	189	277
	Total	251.22	50.376	168	376
Neutrophils	1	2.22	0.65	1.4	2.8
	2	2.07	0.97	1.4	3.2
	3	1.86	0.42	1.5	2.46
	Total	2.05	0.63	1.4	3.2
Lymphocytes	1	1.83	0.86	0.54	2.3
	2	2.03	1.33	0.5	2.85
	3	2.91	0.44	2.47	3.39
	Total	2.28	0.94	0.5	3.39
Lymphocytes	1	0.4	0.24	0.07	0.6
	2	0.37	0.04	0.32	0.41
	3	0.56	0.15	0.34	0.7
	Total	0.45	0.18	0.07	0.7
Eosinophils	1	0.11	0.05	0.04	0.18
	2	0.08	0.07	0	0.14
	3	0.15	0.04	0.1	0.2
	Total	0.12	0.06	0	0.2
Basophils	1	0.02	0.02	0	0.04
	2	0.02	0.02	0	0.04
	3	0.06	0.02	0.03	0.1
	Total	0.036	0.03	0	0.1
Ferritin	1	15.03	3.29	12.7	17.36
	2	15.85	15.49	4.9	26.81
	3	.	.	.	.

Table 2. *ANOVA analysis*

		Sum of Squares	df	Mean Square	F	Sig.
Leukocytes	Between Groups	1.522	2	0.761	0.307	.74
	Within Groups	37.212	15	2.481		
	Total	38.734	17			
Erythrocytes	Between Groups	0.12	2	0.06	1.268	.31
	Within Groups	0.713	15	0.048		
	Total	0.833	17			
Haemoglobin	Between Groups	127.444	2	63.722	1.443	.267
	Within Groups	662.333	15	44.156		
	Total	789.778	17			
Haematocrit	Between Groups	2.702	2	1.351	0.003	.997
	Within Groups	6566.099	15	437.74		
	Total	6568.801	17			
Thrombocytes	Between Groups	16373.78	2	8186.889	4.587	**.028***
	Within Groups	26769.33	15	1784.622		
	Total	43143.11	17			
Neutrophils	Between Groups	0.269	2	0.134	0.286	.758
	Within Groups	3.754	8	0.469		
	Total	4.023	10			
Lymphocytes	Between Groups	2.579	2	1.289	1.615	.258
	Within Groups	6.386	8	0.798		
	Total	8.964	10			
Lymphocytes	Between Groups	0.074	2	0.037	1.125	.371
	Within Groups	0.265	8	0.033		
	Total	0.339	10			
Eosinophils	Between Groups	0.008	2	0.004	1.198	.351
	Within Groups	0.027	8	0.003		
	Total	0.034	10			
Basophils	Between Groups	0.004	2	0.002	3.355	.087
	Within Groups	0.005	8	0.001		
	Total	0.009	10			
Ferritin	Between Groups	0.681	1	0.681	0.005	.948
	Within Groups	250.882	2	125.441		
	Total	251.562	3			

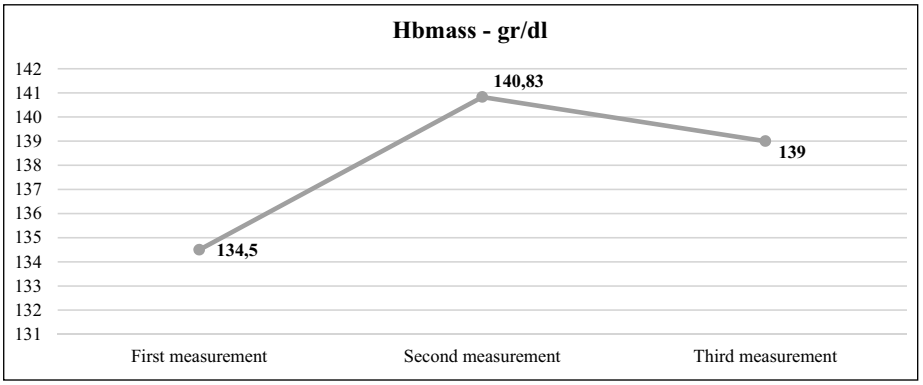

Figure 1. *Line graph showing hemoglobin concentration for three measurements.*

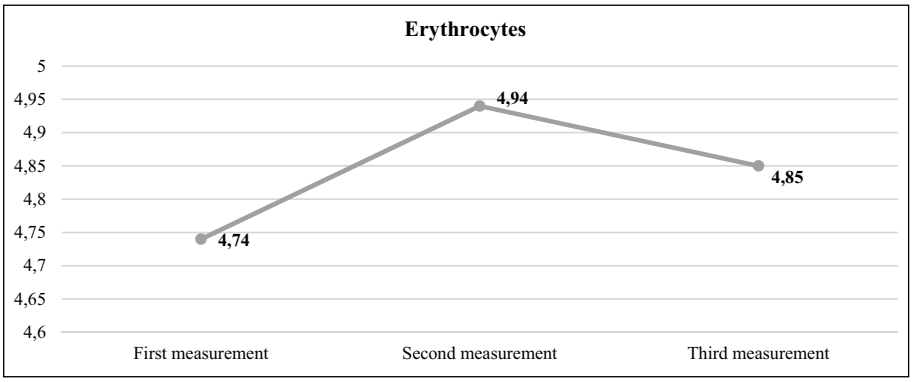

Figure 2. *Line graph showing erythrocytes concentration for three measurements.*

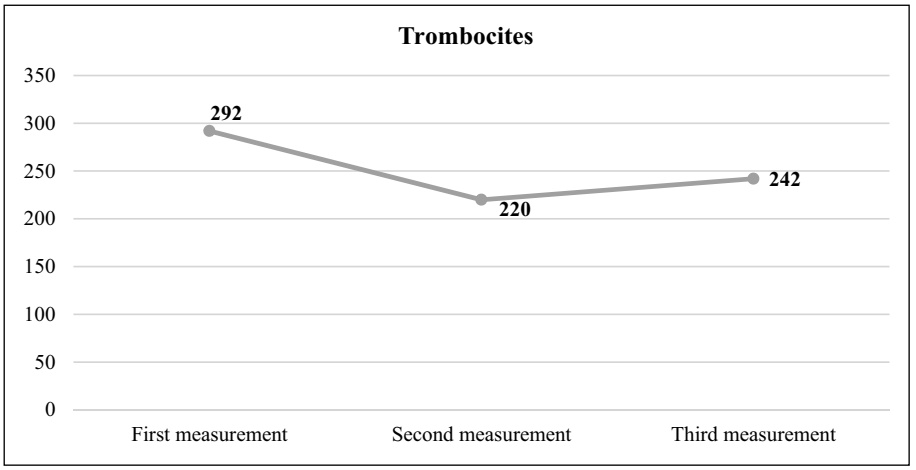

Figure 3. *Line graph showing thrombocytes (platelets)concentration for three measurements.*

DISCUSSION

There is no doubt that altitude exposure, even in elite athletes of various sport types, including elite swimmers, causes an effect on the haematological parameters of living and training at altitude for 3 or 4 weeks.

The present study is designed to compare the hematological parameters of young swimmers training at a high altitude of 2048 m above sea level. Our study showed there was no significant difference in mean Leukocytes, Erythrocytes, Haemoglobin, Haematocrit, Neutrophils, Lymphocytes, Monocytes, Eosinophils, and Basophils. However, their erythropoietin and Hbmass response to altitude exposure might not show the positive effects for young swimmers.

Only for thrombocytes were significant differences found. Whether local or systemic, hypoxia fre-

quently complicates thromboembolism, but its role in altering haemostasis is poorly understood. High-altitude exposure has no significant influence on platelets (Wang et al., 2022). Another possible explanation for arise in platelet count, which have the potential to be taken into account, is an increased physical load during the training camp in Belmeken.

Limitations of the Study

It was the first study that compared the hematological parameters of young swimmers during training camps in Belmeken. Despite the strengths, the sample was so small that drawing conclusions is unreliable.

REFERENCES

Chapman, R.F., Stickford, A.S.L., Lundby, C., and Levine, B.D. (2014). Timing of return from altitude training for optimal sea level performance. *J Appl Physiol* 116:837–843.

Chapman, R. F., Stray-Gundersen, J., Levin, B. D. (1998). Individual variation in response to altitude training. *J Appl Physiol*, Oct;85(4):1448–56.

Dehnert, G., Hütler, M., Liu, Y., Menol, E., Netzer, N., Schick, R., Kubanek, B., Lehmann, M., Böning, D., Steinacker, J.M. (2002). Erythropoiesis and Performance after Two Weeks of Living High and Training Low in Well Trained Triathletes. *Int J Sports Med*; 23(8): 561-566.

Frese, F., Friedmann-Bette, B. (2010). Effects of repetitive training at low altitude on erythropoiesis in 400 and 800 m runners. *Int J Sports Med*, Jun;31(6):382-8

Nadarajan, V., Cheong Hwa Ooi, Sthaneshwar, P., Thompson, M.W. (2010). The utility of immature reticulocyte fraction as an indicator of erythropoietic response to altitude training in elite cyclists. *International Journal of Laboratory Hematology* 32(1 Pt 2): pp. 82–7.

Rusko, H, Tikkkanen, H. (2004). Altitude and endurance training. *Journal of Sports Sciences.* 22, 928–945.

Wang, Y., Huang, X., Yang, W., and Zeng, Q. (2022). Platelets and high-altitude exposure: a meta-analysis. *High Alt Med Biol*. 23:43–56.

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FACTOR STRUCTURE FOR PHYSICAL DEVELOPMENT AND MOTOR ABILITY OF 9-12-YEAR-OLD MALES TAEKWON-DO ITF ATHLETES

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ABSTRACT
Taekwon-do requires explosive strength, flexibility, and balance. The problem of defining factor structures and identifying the major factors for physical development and motor ability is of particular importance for the training process. The aim of the present study was to optimize the major factors of physical development and motor ability of 9–12-year-old males Taekwon-Do ITF athletes. Methodology: The study was carried out in March – May 2019. The research was aimed at studying the major indicators of physical development and motor ability of 9–12-year-old males. It was done among 99 Taekwon-Do athletes (n=99, 10.58 ± 1.13 years, 148.06 ± 11.06 cm, 42.77 ± 11.61 kg) from 9 local Taekwon-do clubs in Bulgaria. Athletes were tested along 16 indicators of physical development and 12 indicators of motor ability. Results: There were 3 factors that explained a total of 89.48% of the initial variance in physical development in males of this age. The test battery contained 16 indicators for testing physical development and after performing the factor analysis, the number was optimized to 3. There were 4 factors that explained a total of 69.15 % of the initial variance in motor ability in males of this age. The test battery contained 12 indicators for testing motor ability and after performing the factor analysis, the number was optimized to 4. Conclusion: Optimizing and reducing the number of factors for physical development and motor ability at the age of 9-12 years would improve the training process in taekwondo sports. In this way, coaches' efforts would be able to target the highest factor weight indicators that would be most affected by the training load applied. Optimizing factors to control athletic achievement would improve athletic performance.

Keywords: *selection, children, martial arts*

INTRODUCTION

Taekwon-do can be described as a high-intensity martial art and modern Olympic sport, in which the main purpose is to defeat the opponent using quick and precise kicks (Cular et al., 2013). Taekwondo requires explosive strength, flexibility, and balance.

The main purpose of control in the field of high sportsmanship is to optimize the training and competition process based on objective information about the effect of the effects applied on the athlete. The Sports Control System covers three subject areas - measurement, evaluation, and optimization. The main function of optimization is to provide the necessary prerequisites for making optimal (maximally effective) decisions for the permanent updating of training effects on factors of athletic achievement (Zhelyazkov, Dasheva, 2011). The problem of defining factor structures and identifying the major factors for physical development and motor ability is of particular importance for the training process (Brogli, 2012). The factors derived determine the characteristics that should be predominantly developed in the study age group. Efforts to raise the level of other traits studied will not have the same training effect and will not significantly increase the level of specific performance (Kolev, 2016) and can be successfully used to optimize the training process (Chanev, 2019).

Successful participants in combat sports like Karate, Judo, Boxing, and Taekwon-do require high levels of technical, tactical, psychological, physical fitness, and physiological characteristics (Chiodo et al., 2012).

PURPOSE

The aim of the present study was to optimize the major factors of physical development and motor ability of 9-12-year-old males ITF Taekwon-Do athletes.

METHODS

The study was carried out in March – May 2019 and included 99 taekwondo athletes aged 9-12 years (10.58 ± 1.13 years, 148.06 ± 11.06 cm, 42.77 ± 11.61 kg) from 9 local Taekwon-do clubs in Bulgaria. All participants freely volunteered to participate in this study. Athletes were tested along 16 indicators of physical development and 12 indicators of motor ability. These indicators carried information of physical development and motor ability. All participated teams received detailed information about

the study risks and benefits and the testing procedures. This information was communicated to the athletes of each team by its head coach. All participants or their parents (in the case of underage participants) provided written informed consent.

Included tests for physical development indicators were height (cm), weight (kg), extension horizontal (cm), extension vertical (cm), length of the lower and upper limb (cm), circumference of the arm and forearm (cm), muscle circumference of the arm forearm (cm), etc. Parameters were assessed in this article as body mass index (kg/m^2), percentage of subcutaneous fat (%), the absolute amount of subcutaneous fat, active body mass, the absolute amount of muscle mass, hip and cheekbone corrected circumference, and arm and hip muscular circumference. Body fat (BF) was determined with caliperometria. The circumferences of the body were measured with a tape measure (Slanchev, 1992). Included tests for motor ability indicators were tests used to assess the physical fitness of students in grades I through XII by 2019 (sit-ups, long jump, 300/600 meters run, and throwing a medical ball) and from 2019 (long jump, throwing a medicine ball and shuttle run). Specialized tests were also included (push-ups, leaps over the gym bench laterally, vertical jump, split left, split right, side twine, and forward by Euro fit). Data were analyzed statistically with descriptive statistics and factor analysis (varimax matrix method). All statistical analyses were performed using SPSS version 25.

RESULTS

The study included athletes representing all weight categories for these age groups and gender in ITF Taekwon-do. The data presented in (Table 1) showed mean values of physical development and motor ability of 9-12-year-old males. The biggest variations were observed in the percentage of subcutaneous fat and the absolute amount of subcutaneous fat.

Table 1. *Mean values of physical development and motor ability of 9-12-year-old male*

Indicators	Mean ± SD	V	Indicators	Mean ± SD	V
Age	14.47±2.06	14.23	Lower limb length	14.50±1.34	9.24
Height	168.74±10.77	6.38	Upper limb length	164.89±7.32	4.43
Weight	61.55±13.72	22.29	Push-ups	56.88±8.66	15.22
Active body mass	11.93±0.71	5.95	Sit-ups	12.09±0.64	5.29
Extension horizontal	7.36±1.78	24.18	Long jump	6.86±1.20	17.49
Circumference of the armpit	54.18±12.00	22.14	Shuttle run 8x10 m	49.76±7.60	15.27
Circumference of the forearm	29.23±7.29	24.94	Throwing a medical ball	27.00±4.99	18.48
Muscle circumference of the armpit	21.25±1.75	8.23	Vertical jump	20.40±5.15	25.24
Absolute amount of muscle mass	21.36±2.95	13.81	Leaps over the gym bench laterally	19.91±2.95	14.81
Circumference of the shank	25.30±3.36	13.28	Leaps over the gym bench laterally	22.98±2.18	9.48
Circumference of the thigh	48.84±5.09	10.42	Side twine	48.11±3.92	8.17
Muscular circuit of the thigh	42.38±7.05	16.63	Split left	85.54±11.38	13.30
Percentage of subcutaneous fat	6.29±3.17	50.39	Split right	87.20±13.55	15.53
Extension vertical	131.52±10.11	7.68	Forward by Euro fit	102.75±8.41	8.18
Absolute amount of subcutaneous fat	2.45±1.09	44.48			

SD – standard deviation, V- coefficient of variance

All indicators of physical development (16) were subjected to factor analysis. After the rotation, three major factors were identified that explained a total of 89.48% of the variance explained. These factors occupied a high relative share (over 10%) and the initial variance was 10.52% (Table 2).

Table 2. *Factor matrix of indicators of physical development of 9–12-year-old males*

№	Name of indicators	ME	Factor 1	Factor 2	Factor 3	h^2	$1-h^2$
1.	Active body mass	kg	.584	.449	.641	.954	.046
2.	Weight	kg	.622	.458	.586	.940	.060
3.	Circumference of the armpit	cm	.396	.470	.718	.893	.107
4.	Circumference of the forearm	cm	.396	.470	.718	.893	.107
5.	Muscle circumference of the armpit	cm	.416	.458	.694	.865	.135
6.	Absolute amount of muscle mass	kg	.313	.882	.321	.979	.021
7.	Circumference of the thigh	cm	.177	**.932**	.296	.988	.012
8.	Circumference of the shank	cm	.177	**.932**	.296	.988	.012
9.	Muscular circumference of the thigh	cm	.182	**.941**	.259	.986	.014
10.	Extension horizontal	cm	**.868**	.288	.201	.877	.123
11.	Height	cm	**.875**	.283	.000	.850	.150
12.	Percentage of subcutaneous fat	%	-.148	-.251	**-.871**	.844	.156
13.	Lower limb length	cm	**.888**	.310	.000	.884	.116
14.	Extension vertical	cm	.782	.264	.139	.701	.299
15.	Upper limb length	cm	.884	-.293	.234	.923	.077
16.	Absolute amount of subcutaneous fat	kg	.168	.000	**-.847**	.755	.245
∑a2=89.48%			**32.25%**	**30.94%**	**26.30%**		

The first factor explained the highest percentage (32.25%) of the initial variance of physical development in 9–12-year-old males (Table 2). It was constructed from three indicators that revealed the high importance of body proportions and could be defined as "morphological, related to body lengths". The second factor explained 30.94% of baseline variance and was related to the length of the lower limb in 9–12-year-old males and could be defined as "morphological, related to the size of the lower limb". The third factor (constructed from two indicators) explained 26.30% of the initial variance of physical development and could be defined as "body mass". Thus, the number of physical development indicators in males was reduced to 8.

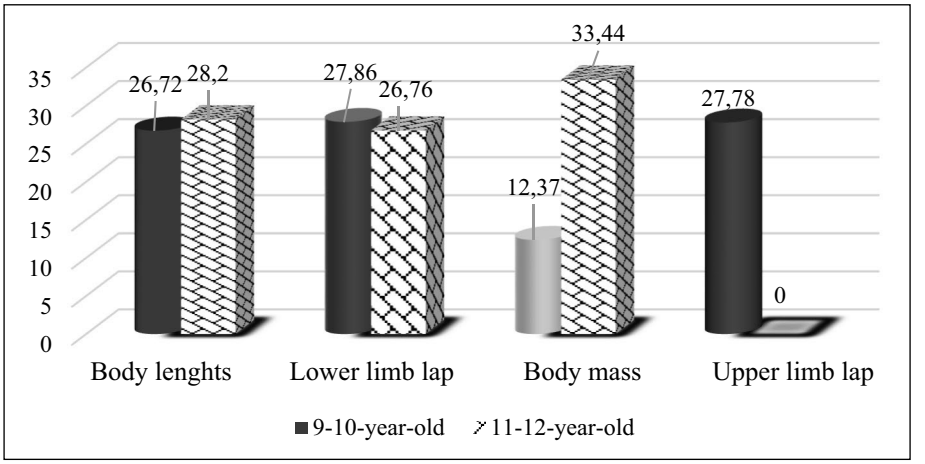

Figure 1. *Calculated indicators of physical development in 9-10-year-old and 11-12-year-old males*

The factors with the highest factor weight for physical development in the age groups 9-10 and 11-12 years are presented (Figure 1). It is noteworthy that the first three factors have a high percentage of the initial variance in both age groups. Body lengths were the factor that mat-

tered most in both age groups. In addition to being a martial art, Taekwon-Do is a categorical sport where the lengths of the upper and lower limbs are extremely important. Keeping the desired distance from the opponent, which will be uncomfortable for him, can be achieved more easily when the competitor has longer limbs and low body weight.

Table 3. *Factor matrix of indicators of motor ability to 9-12 years old males*

№	Name of indicators	ME	Factor 1	Factor 2	Factor 3	Factor 4	h^2	$1-h^2$
1.	Side twine	cm	**.857**	.224	.000	.000	.797	.203
2.	Split right	cm	**.960**	.000	.000	.000	.934	.066
3.	Push-ups	n	.261	**.743**	.188	.000	.661	.339
4.	Split left	cm	**.943**	.000	.000	.000	.893	.107
5.	Shuttle run 8x10 m	s	.000	**-.813**	-.126	.000	.684	.316
6.	Long jump	cm	.104	.334	.678	.328	.690	.310
7.	Sit-ups	n	.000	**.783**	.000	.188	.658	.342
8.	Forward by Euro fit	cm	.332	.214	.319	-.174	.288	.712
9.	Throwing a medical ball	cm	.000	.380	.000	**.747**	.711	.289
10.	Vertical jump	cm	.000	.000	**.757**	.000	.582	418
11.	Leaps over the gym bench laterally	n	.000	.000	**.802**	.120	.670	.330
12.	300/600 m run	s	.000	.000	.000	**.840**	.728	.272
∑a2=69.15%			**23.08**	**18.37**	**15.48**	**12.22**		

The first mobility factor was composed of 3 indicators and explained 28.02% of the initial variance and could be characterized as "lower limb flexibility" (Table 3). The second factor explained 18.37% of the variance explained and was made up of three factors. It could be defined as "dynamic force of the upper and lower limbs". The third factor covered two indicators and explained 15.48% of the variance and could be characterized as "lower limb blasting force". The fourth factor explained 12.22% of the variance and covered two indicators that characterize it as "dynamic upper limb strength". The test battery contained 12 indicators for testing motor ability and was optimized to 10.

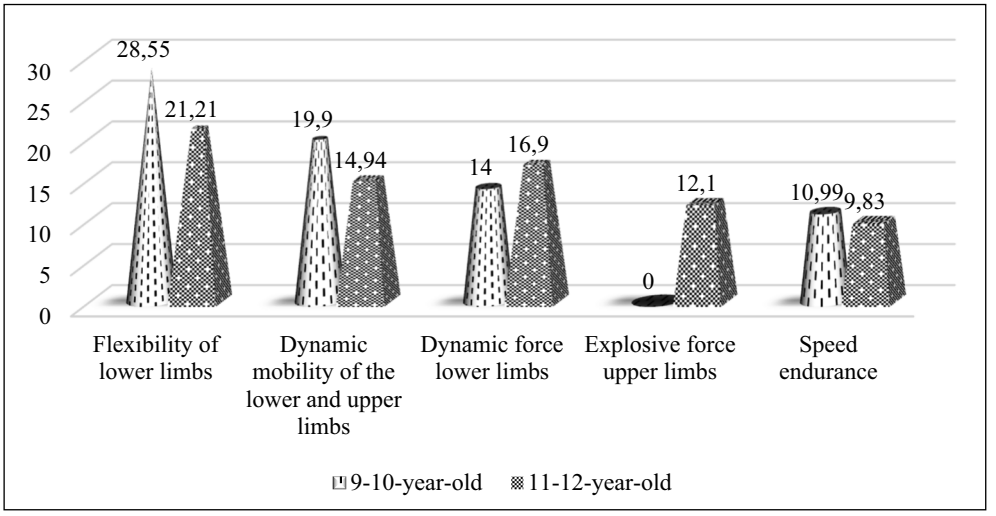

Figure 2. *Calculated indicators of motor ability in 9-10-year-old and 11-12-year-old males*

The factors with the greatest factor weight for motor ability at ages 9-10 and 11-12 years were presented (Figure 2). The well-developed flexibility of the lower limbs and the dynamic mobility of the upper and lower limbs allow during the fight to perform quick and accurate blows at different heights. It was

noteworthy that the indicators had been identical across the two age groups. The order of the indicators was different, as was the percentage of initial variance they had explained. This was a reason for reduced again the number of indicators to be included in the regulatory framework. Recurring factors had been left with the highest percentage of explained variance. In terms of physical development, these were: extension horizontal, extension vertical, lower limb length, body fat percentage, muscle circumference of the armpit and thigh. The highest factor for motor ability were a shuttle 8x10 m, throwing a medical ball, jump over a gym bench laterally and a split left.

DISCUSSION

Central to the scientific and methodological provision of control was the regulatory framework for the evaluation and optimization of the main factors of sports achievement (Zhelyzkov, Dasheva, 2011). According to the authors, an evaluation system with high criteria for the reliability of the studied factors or their individual components and the creation of optimization models with selective impact on the various factors of sports achievement were some of the key elements.

To date, the majority of authors have focused on defining single factors, e.g., morphological factors that reveal the importance of growth and weight for successful development (Borukova, 2019; Borukova, 2017; Chanev, 2019; Kolev, 2016), structure (Pieter, 2010; Toskovic et al., 2004), biomechanics (Markovic et al., 2005; Wasik, 2009), physiology (Zar et al. 2008), coordination (Sadowski, Gierczuk, 2009; Zar et al., 2008) and conditioning (Melhim, 2001), and the correlations of these with competition results.

The most important success factors in sports included body build, conditioning, technical and tactical skills, mental abilities, and the experience of a competitor (Toskovic et al., 2004).

Some authors decided to group them in the following way: structural factors, conditioning and flexibility factors, technical factors, coordination factors, and energetic factors (Sadowski et al., 2012). They found that successful competitors (medalists) demonstrated significantly better technique, conditioning, and flexibility parameters. Technical skills (e.g., strikes and side and roundhouse kicks), speed, dynamic strength, and endurance were the factors that contributed to the achievement of excellent results in Taekwon-Do (Sadowski et al., 2012).

The analysis of factor structures for physical development in 9-12-year-old girls showed that there are three factors (morphological, related to the circumference of the upper limb, morphological, related to the circumference of the lower limb and body mass). Factor structure analysis of motor ability in 9-12-year-old girls showed that there were four factors - flexibility of the lower limbs, dynamic mobility of the upper and lower limbs, dynamic strength of the upper limbs, and explosive power of the lower limbs (Neykov, Ilieva-Sinigerova, 2020).

Given the unfinished growth period and ongoing changes in morpho-anthropometric characteristics, it should be borne in mind that the calculations made reference to the specific age group and weight categories and should not be used for other age groups (Ilieva-Sinigerova, 2019). Indicators characterizing body mass composition were influenced to a very large extent by the training process, and coaches should focus their efforts on optimizing their values for the specific athlete and weight category (Ilieva-Sinigerova, 2020).

At the age of 9-12 Taekwon-Do athletes (males and females) had demonstrated almost equal levels of motor ability. Considering the age and gender characteristics and the paucity of studies on motor abilities in 9–12-year-olds, it was necessary to carry out systematic and targeted studies to be able to make clearer conclusions (Ilieva-Sinigerova, 2019).

So far, insufficient research has been found on the problem under study for 9–12-year-old taekwondo athletes.

CONCLUSION

The analysis of the results and the factor structure of physical development and motor ability of 9–12-year-old males allowed us to formulate the following *conclusions*:

The analysis of the factor structures of physical development of 9–12-year-old males showed that there were three factors established for both groups which explained a high percentage of initial dispersion - 89.49 %. The analysis of the factor struc-

tures of the motor ability of 9–12-year-old males showed that there were four factors established for both groups which explained a high percentage of initial dispersion – 69.15 %. After performing the factor analysis, the number of factors in males in this age group had been optimized from 16 to 3 (morphological, related to body lengths, morphological, related to the size of the lower limb, and body mass). After performing the factor analysis, the number of factors in males in this age group had been optimized from 12 to 4 (lower limb flexibility, dynamic force of the upper and lower limbs, lower limb blasting force, and dynamic upper limb strength).

Optimizing and reducing the number of factors for physical development and motor ability at the age of 9-12 years would improve the training process in Taekwon-Do sport. In this way, coaches' efforts would be able to target the highest factor weight indicators that would be most affected by the training load applied. Optimizing factors to control athletic achievement would improve athletic performance in 9–12-year-old Taekwon-Do athletes.

REFERENCES

Borukova, M. (2019). Factor structure and major factors of physical ability of 13-14-year-old pupils. *Journal of Applied Sport Science*, Vol. 1, pp. 77-84.

Borukova, M. (2017). Management and control of sports preparation of 14-15-year-old female basketball players. *Journal of Applied Sport Science*, Vol. 2, pp. 21-32.

Brogli, Y. (2012). Vavedenie v teoriata i praktikata na kontrola varhu faktorite na sportnoto postijenie, *NSA Press*. // Брогли, Я. (2012). Въведение в теорията и практиката на контрола на спортното постижение. *НСА Прес*.

Chanev, S. (2019), Faktorna struktura i osnovni faktori na fizicheskoto razvitie i specifichnata rabotosposobnost na 18-godishni handbalisti. *Sport i nauka*, vol. 1,2, pp. 45-54. // Чанев, С. (2019), Факторна структура и основни фактори на физическото развитие и специфичната работоспособност на 18-годишни хандбалисти, *Спорт и наука*, бр. 1,2, стр. 45-54.

Chiodo, S., Tessitore, A., Lupo, C., Ammendolia, A., Cortis, C., Capranica, L. (2012). Effects of official youth taekwondo competitions on jump and strength performance. *European Journal of Sport Science,* Vol. 12, pp. 113-120.

Cular, D. et al. (2013). Predictors of Fitness Status on Success in Taekwondo, *Anthropological,* Vol. 4, pp. 1267-1274.

Ilieva - Sinigerova, S. (2019). Izsledvane na morfo-antropometrichni priznatsi pri 9-12 godishni sastezateli po taekwon-do i vliyanieto im varhu podbora. *Sport i nauka*, vol. 5, pp. 29-39 // Илиева-Синигерова, С. (2019). Изследване на морфо-антропометрични признаци при 9-12 годишни състезатели по таекуон-до и влиянието им върху подбора. *Спорт и наука*, бр. 5, стр. 29-39.

Ilieva-Sinigerova, S. (2019). Motor ability profile of 9-12 years old taekwondo athletes. *International Scientific Congress "Applied sports science", 15-16.11.2019, Proceeding book*, pp. 122-125. ISBN: 978-954-718-601-9.

Ilieva – Sinigerova, S. (2020). Zavisimosti mejdu pokazateli za fizichesko razvitie pri 9-12 godishni sustezateli po taekwon-do. *Sport i nauka*, vol. 3,4, pp. 34-43 // Илиева-Синигерова, С. (2020). Зависимости между показатели за физическо развитие при 9-12 годишни състезатели по таекуон-до. *Спорт и наука*, бр. 3,4, стр. 34-43.

Kolev, I. (2016). Faktorna struktura na fizicheskoto razvitie i specifichnata rabotosposobnost na 11-12 – godishni koloezdachi. *Sport I nauka*, Vol. 4, pp. 23-28. // Колев, И. (2016). Факторна структура на физическото развитие и специфичната работоспособност на 11-12-годишни колоездачи. *Спорт и наука*, бр. 4, стр. 23-28.

Neykov, S., Ilieva-Sinigerova, S. (2020). Optimizirane na broia na pokazatelite za fizichesko razvitie i dvigatelna godnost chrez factoren analiz pri 9-12 godishni sustezatelki po taekwon-do itf. *Sport I nauka*, Vol. 3,4, pp. 5-14 // Нейков, С., Илиева-Синигерова, С. (2020). Оптимизиране на броя на показателите за физическо развитие и двигателна годност чрез факторен анализ при 9-12 годишни състезателки по таекуон-до ITF. *Спорт и наука*, бр. 3,4, стр. 5-14.

Pieter, W. (2010). Talent Detection in Taekwondo Practitioners. *Journal of Asian Martial Arts*, Vol. 19, No. 3, pp. 9–29.

Sadowski, J., Gierczuk D. (2009). Correlations between selected coordination motor abilities and technical skills of Greco-Roman wrestlers aged 14–15. *Archives of budo, Science of martial arts,* Vol. 5, pp. 35–39.

Sadowski, J. et al. (2012). Success factors in elite WTF taekwondo competitors. *Archives of budo, Science of martial arts*, Vol. 8, No. 3, pp. 141-146.

Slanchev, P. (1992). Sportna medicina: Uchebnik za studenti ot NSA. *Medicina I fizkultura,* Sofia // Слънчев, П. (1992), Спортна медицина: Учебник за студенти от НСА, София, Медицина и физкултура.

Markovic, G., Misigo-Durakovic, M., Trninic S. (2005).

Fitness profile of elite Croatian female taekwondo athletes. *Collegium Anthropologicum*, Vol. 29, No.1, pp. 93–99.

Melhim, A. (2001). Aerobic and anaerobic power responses to the practice of taekwon- do. *British journal of Sport Medicine*, Vol. 35, No. 4, pp. 231–234.

Toskovic, N. N., Blessing, D., Williford. H. N. (2004). Physiologic profile of recreational male and female novice and experienced Tae Kwon Do practitioners. *Journal of Sports Medicine and Physical Fitness*, Vol. 44, No. 2, pp. 164–172.

Wąsik, J. (2009). Structure of movement of a turning technique used in the event of special techniques in Taekwon-do ITF. *Archives of budo*, Science of martial arts, Vol. 5, pp. 111–15.

Zar, A., Gilani, A., Ebrahim, K., Gorbani, M. (2008). A survey of the physical fitness of the male taekwondo athletes of the Iranian National Team. *Physical Education and Sport*, Vol. 6, pp. 21–29.

Zhelyazkov, Ts., Dasheva D. (2011). Osnovi na sportnata trenirovka. *Bolid-Ins,* Sofia. // Желязков, Цв., Дашева, Д. (2011). Основи на спортната тренировка. *Болид-Инс,* София.

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CRITERIA FOR SWITCHING TO INDIVIDUAL TRAINING SESSIONS IN CHESS

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ABSTRACT
The aim of this research was to establish clear criteria for the readiness of 10-14-year-old chess players to switch from group to individual training sessions and consequently to achieve a higher level in their chess preparation. We assumed that the purposeful application of certain criteria in the educational-training process would lead to selecting players with the necessary actual and potential possibilities to switch to an individual training plan. To analyze the range of sports parameters accelerating young chess players' progress, we obtained the opinion of 42 leading chess specialists. They were asked to range the suggested eight criteria for switching from group to individual training plan according to their importance: 1. player's chess rating. 2. results in National tournaments. 3. results in FIDE-rated Open tournaments. 4. efficiency in assignments for self-practice. 5. playing custom positions against Stockfish 14.1. chess engine. 6. results in in-club training tournaments. 7. regular participation in the educational-training process. 8. rating dynamics over the last six months. The results showed that most chess players consider criterion 1 as the most informative, followed by the competencies along criteria 7 and 4. The specialists were not unanimous about the exact arrangement of the leading three indicators. However, they did not attach any importance to criteria 5 and 6.

Keywords: *chess education, individual chess training mode, chess rating dynamics.*

INTRODUCTION

The topicality of the issue concerning switching to individual training sessions is related to the need to perfect the system of young chess players' professional preparation and consider the contents of the training process.

The system for the preparation of young chess players should regard not only the general skills and knowledge but also the individual peculiarities of each player. Observations of many years show that all young chess players have their own curve of success and sports achievements, and the criteria are mainly the positive change in the individual ranking and medals from national and international competitions. However, this is only the cursory dynamics of the process reflecting hardships and obstacles young chess players overcome when learning a particular educational material. These facts lead to the hypothesis about the need of individual training sessions with some competitors.

The main *aim of this study* was to create criteria for switching from group to individual training sessions of young chess players.

In the methodological literature, the impact of chess players' personal characteristics on their competitive skills was studied by Vollstädt-Klein et al. (2010). Individual characteristics, being a premise for chess playing at a young age, were in the center of a large-scale survey (Bilalic et al., 2007), whose results showed that children who scored high in intellect were more apt to be attracted to the game of chess, while children who scored higher on agreeableness did not take up chess as a hobby. Whether the ability in chess depends on some other abilities (such as spatial aptitude, perceptive speed, reasoning, creativity, or general intelligence) was discussed by Albert Frank (2011). His research confirmed a positive influence of learning chess on the development of numerical and verbal aptitudes, as chess utilizes all the abilities of an individual, and they all work together whenever the game is played.

Switching from one to the other form of training, however, has been poorly studied, without the necessary scientific argumentation.

The advantages of individual chess training are undisputable. Nevertheless, the intensity of the load, the tempo of learning the new material, and the other educational points should be regulated on the basis of:

- Players' age peculiarities (Gobet, Campitelli, 2007); level of chess mastery (the higher the players' chess level, the more material they should learn and use in their play). Also, mastering chess skills requires persistence which may impede studying other subjects included in the school curriculum (Campitelli, Gobet, 2008).

- Players' individual chess peculiarities (some players learn certain material after the initial explanation while others need repetition, and the rest require further explanation or more practice; some are intuitive at combination motives, while others should work more on their tactical vision (Gong et al., 2015); some are good at learning the principles of positional play during their 1-2 years of practice, while others reach the same level of positional play over a longer period of time). In other words, the successful learning of the educational material, the tempo of its learning, and the stability of the acquired knowledge depend not only on coaches' activities but also on players' cognitive abilities and skills. These abilities, in turn, are affected by a number of factors such as personal perception skills, memory, attention (De Groot, 2008; Sala et al., 2015; Burgoyne et al., 2016), concentration, and mental activity, as well as physical development (Fuentes-Garcia et al., 2019).
- The set aims and the sought result (it is important for some players to win in the forthcoming competition, others struggle to catch up on the material in group trainings, and the rest build career as professional chess players).

The significance of the form of preparation of chess players is directly related to the results. The establishment of the degree of interrelation and interconnection between the increase in the load and the intensity of individual assignments and the increase in players' abilities (direct effect) and sports results (indirect effect) is an important element of the form of preparation. The correct selection of this model has been discussed by lots of authors. Charness et al. (2005) researched the influence of frequency and duration of engagement in a variety of chess-related activities on results. A recent analysis showed that over 50% of the variance in chess rating could be accounted for by practice-related variables (Burgoyne et al., 2019).

Pluss et al. (2019) viewed the issues related to forecasting and controlling competitors' sports achievements through a selection of proper organizational forms, optimization of the process on the basis of each chess player's individual abilities.

Calderwood et al. (1988), and Blanch, Llaveria (2021) believed that the set of assignments and the form of training for a particular level should be created on the basis of indexes for the level of strategic mastery. The advantages of individual training sessions are indisputable. Besides the most popular ones, we should point out that they help coaches to efficiently determine the level of Rapid Decision Making on the basis of recognition-primed decision (RPD), viewed by Klein (1993), and to be flexible in applying suitable individual trainings for its improvement.

Hypothesis

While researching the literature, we came up with the issue leading to this survey – lack of clear criteria for evaluation of chess players' readiness to switch from group to individual form of training and as a result – inability to do such a move.

As a result of the analysis of this problem, we made a *hypothesis* according to which the purposeful use of certain criteria in designing an educational-training process would lead to selecting players who should switch to an individual or mixed type of training and would also lead to an increase in the efficiency of the whole training process. Kilger (2017) staked on selectivity while guaranteeing the right of each child to take part in chess training sessions.

METHODS

Entity sample

In order to analyze the range of sports parameters which help achieving a higher chess level, we asked the opinion of some leading chess specialists. In the survey took part 33 experts with a professional chess profile and long-term training experience, working with children from 10 to 14 years of age. The sample was not representative.

Procedures and tastings

The participants in the research were given paper-based questionnaires for evaluation of the degree of importance of the following indicators, scaled from 1 to 10: 1. Individual rating of classic chess players. Competitors' current rating at the moment of evaluation is important for their ability to switch to an individual training regime. 2. Competitors' results from national championships. Only the results from the latest sports-competitive year are taken into consideration. 3. Competitors' results from open tournaments and their international rating. The achievements from the latest four tournaments are considered as well as the ranking and the

level of achievements. 4. Competitors' grades on individual assignments. The grades are compared with those of other players – relative grades and absolute grades as a percentage of successfully solved assignments. 5. Competitors' grades when playing in training against the program Stockfish 14.1. The relative grades compared to those of other players with identical knowledge are taken into account. 6. Competitors' results from training tournaments. Their points are compared to those of other players on a similar level. 7. Regular participation in the educational-training process. 8. Dynamics of the rating in the last 6 months.

The sample was purposive of the "accessibility" type, and the conclusions drawn are valid only for the individuals studied. The children took part in the pedagogical experiment after we had received informed consent on behalf of their parents, according to the requirements of the Helsinki Convention on the Rights of the Children.

The selection of the above eight indicators comprises the results in competitive and training settings and the sequence of learning educational-training material. We took into account a number of research on the significance of the different components of chess training, some discussions with leading chess specialists, as well as our own coaching and pedagogical experience. Gobet and Campitelli (2007) reported that the amount of accumulated hours of practice is between 3,000 and 23,600 h to attain the master level. They found a strong relationship between limiting factors such as early experiences and aging and attained skill and chess rating (Roring III, 2008).

Chess engines have improved tremendously in recent years and the benefits of their use are widely known and discussed (Acher, Esnault, 2016, Konchev, 2019). We decided to use Stockfish 14.1 because it is the highest-rated chess engine available to the public. One of the important positive effects of training tournaments (criterion 6) is the feedback about players' psychological reactions during the different parts of the chess game – the time distribution for different moves, as well as the identification of shortcomings and problems which should be worked on. They are often related to impulsiveness or lack of determination upon taking a decision and through training tournaments, they can be avoided. This also helps the process of developing a player.

After a careful analysis of a great amount of methodological literature (Perotti et al., 2013, Engqvist, 2016, Grooten, 2017) and on the basis of our own survey among leading chess pedagogues and our personal coaching experience, we selected to use the following chess methodological approaches: 1. Organization of sessions on certain chess topics with highly qualified specialists. 2. Exercise method (solving especially selected topic positions aimed at creating specific habits and skills). 3. Play method (playing educational positions or parts of games with a partner; sessions; solving problems competitions). 4. Method for analysis of chess games and typical positions (analysis of gross masters' games; analysis of games played by competitors from the groups for group and individual training; analysis of debut typical positions, middlegame, and endgame positions).

Variables

The survey card contains closed-ended questions. The possible answers to the questions in the survey are scaled on weak scales - nominal and ordinal, which gives reason to use the following statistical methods for the analysis of the results:

Statistical analysis

The SPSS v.23 software package was used for data processing. For the purposes of the analysis, the following mathematical and statistical methods are used: Frequency analysis; Kendall's W Test; Kruskal-Wallis Test, and $\chi 2$ Test.

RESULTS AND DISCUSSION

Table 1. *Pattern Matrix for Current Practice Activities*

Measure	Variable	Solitary Study	Instruction	Group Study	Blitz	Casual Games	Tournaments	Problem Solving Others	Rapid Play	Position Study Alone
Diary	Blitz	-0.05	-0.03	0,00	**0.76**	-0.04	-0.04	0.14	-0.1	-0.06
Diary	Rapid	-0.13	0.00	0.01	-0.06	0.19	0.06	0.06	0.33	-0.12
Diary	Computer Play for fun	-0.05	-0.03	0.53	-0.03	**0.34**	-0.09	-0.12	0.00	0.16
Diary	Human play for fun	0.01	0.07	-0.03	**0.50**	-0.16	-0.35	-0.09	0.32	-0.06
Diary	Tournament play	-0.07	-0.07	0.09	-0.05	-0.02	0.37	-0.15	0.16	-0.17
Diary	Instruction	0.01	**0.98**	-0.06	-0.04	0.02	-0.1	0.08	0.02	0.00
Diary	Endgame with others	0.05	-0.05	**0.71**	0.05	-0.05	0.04	0.16	-0.04	‘-0.1
Diary	Middlegame with others	0.00	0.10	**0.91**	-0.04	-0.03	0.07	-0.11	-0.01	-0.08
Diary	Opening with others	-0.11	0.51	0.31	0.00	-0.05	-0.05	0.01	-0.01	0.15
Diary	Prob Solving with others	-0.04	0.15	0.02	0.05	0.14	0.05	0.82	-0.07	-0.06
Diary	Endgame alone	0.92	-0.04	0.07	0.00	-0.08	0.03	0.07	0.02	-0.1
Diary	Middlegame alone	**1.00**	0.01	0.01	0.03	0.14	0.00	-0.11	-0.09	-0.07
Diary	Opening alone	**0.65**	0.15	-0.12	0.00	-0.05	0.11	-0.13	0.03	0.1
Diary	Prob Solving alone	**0.44**	-0.12	0.01	-0.11	0.00	-0.15	0.38	0.03	0.18
Diary	Databases	-0.02	0.04	-0.08	-0.06	-0.03	0.14	0.30	0.09	0.1
Quest	Position study alone	-0.09	0.06	-0.19	0.01	0.01	0.09	-0.03	-0.01	0.75
Quest	Reading for fun	0.01	-0.04	-0.06	-0.03	0.12	**0.44**	0.03	-0.02	0.11
Quest	Tornament play	0.12	0.12	0.04	-0.05	-0.05	**0.50**	-0.02	0.08	0.04
Quest	Blitz	0.03	-0.02	0.00	**0.94**	0.17	0.14	-0.1	-0.09	0.13
Quest	Rapid	0.02	0.01	-0.05	-0.07	0.10	0.17	-0.05	**0.82**	0.11
Quest	Casual games	0.05	-0.03	0.00	0.03	**0.71**	‘-0.10	0.09	0.34	-0.09
Quest	Chess computer play	0.00	0.03	0.00	0.04	**0.77**	0.05	0.07	-0.03	0.00
Quest	Instruction	0.07	**0.86**	-0.01	0.04	0.01	0.11	0.08	-0.01	-0.05
Quest	Problem solving	0.14	-0.07	0.2	0.05	-0.11	-0.04	0.08	0.09	**0.61**
Quest	Position study with others	-0.03	-0.07	0.07	0.15	-0.12	**0.69**	0.24	0.15	0.01

When selecting the criteria, we considered contribution of Blanch (2020), Holding (2021). They divided the exercises into competitive exercises and exercises for special preparation, emphasizing the exercises for special preparation. The statistical processing of the results presented (Table 1) aimed to reveal the leading criteria according to the specialists. Thus, coaches will be able to make their activity related to player selection for switching to individual chess training more efficient.

With “1” the experts evaluated the most important criterion, and with “8” – the least important one. On the basis of expert evaluation, we calculated Kendall’s W consistency coefficient. Theoretically, this coefficient has values ranging from 0 to 1, as follows:

Kendall’s W consistency coefficient

$$[0,1] = \{W | 0 \leq W \leq 1\} \quad (1)$$

0 – „no agreement” – the indicators are different in importance for the level of preparation of 10-14-year-old children for switching from group to individual form of preparation.

1 – „total agreement” – the indicators are equally important for the level of preparation of 10-14-year-

old children for switching from group to individual form of preparation.

The calculated ranks are made normative by mini-max transformation within the range from 0 to 1 are shown in *Equation 2*, where:

0 – indicator with major meaning;

1 – indicator with the lowest degree of importance.

Mini-max transformation of calculated ranks

$$x_{scaled} = \frac{x - x_{min}}{x_{max} - x_{min}} \quad (2)$$

The obtained values are rescaled within the range from 0 to 1. An indicator with major meaning is marked with "1", and an indicator with the lowest degree of importance – with "0". The relative significance of each of the researched indicators is calculated with a formula shown on *Equation 3*.

Relative significance of the researched indicators

$$Y_{i\%} = \frac{x_i}{\sum_{i=1}^{8} x_i} . 100 \quad (3)$$

The processing of the data was made with the software package SPSS v.23. for the purposes of the analysis, we used the following *math-statistical methods*: frequency analysis; Kendall's W Test; Kruskal-Wallis Test; χ^2 Test.

The summarized results from the expert evaluation of the indicators for switching from group to individual form of preparation of 10-14-year-old children are shown in Table 2.

Table 2. *Distribution of the marks for the level of preparation*

№	Criteria	Degree of importance	Experts (n)	Relative share (%)[a]
1	Player's chess rating	1	10	30.3
2	Results in National tournaments	3	12	36.4
3	Results in FIDE-rated Open tournaments	4	9	27.3
4	Efficiency in assignments for self-practice	5	9	27.3
5	Efficiency in playing custom positions against Stockfish 14.1. chess engine	8	11	33.3
6	Results in in-club training tournaments	7	13	39.4
7	Regular participation in the educational-training process	1	7	21.2
8	Rating dynamics over the last 6 months	8	12	36.4

a – the highest relative share of the experts who marked the degree of importance

Kendall's W consistency coefficient had a low value (0.221). It is statistically significant at 5% significance level (Sig=.000<.05). This allowed us to grade the researched indicators according to their degree of importance. The average-rank evaluations are shown in Table 3.

Table 3. *Average-rank values of the researched indicators*

Criteria	Average rank
Player's chess rating	3.35
Results in National tournaments	3.65
Results in FIDE-rated Open tournaments	3.52
Efficiency in assignments for self-practice	3.89
Efficiency in playing custom positions against Stockfish 14.1. chess engine	5.83
Results in in-club training tournaments	5.73
Regular participation in the educational-training process	4.03
Rating dynamics over the last 6 months	5.98

CONCLUSIONS

In conclusion, we can say that players' individual rating is the major criterion for switching from group to individual form of training. This relation between rating and individual training sessions was also found by Charnes et al. (1996)

Rating is a leading criterion for switching to individual training sessions, which in turn are a leading factor for increasing the rating.

Players' results from national and international tournaments are also with quite a big relative share. The same interdependence as players' rating can be applied here, too. Another factor that should also be taken into consideration is players' grades on individual assignments. The rest of the criteria can be influential too but to a smaller extent.

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REFERENCES

Acher, M., Esnault, F. (2016). Large-scale Analysis of Chess Games with Chess Engines: A Preliminary Report. *arXiv:1607.04186v1*, https://doi.org/10.48550/arXiv.1607.04186

Bilalić, M., McLeod, P., & Gobet, F. (2007). Personality profiles of young chess players. *Personality and Individual Differences*, 42, 901–910. https://doi.org/10.1016/j.paid.2006.08.025

Blanch, A. (2020). *Chess and Individual Differences*. Cambridge University Press.

Blanch, A., Llaveria, A. (2021). Ability and non-ability traits in chess skill. *Personality and Individual Differences*, 179 (2). https://doi.org/10.1016/j.paid.2021.110909

Burgoyne, A., Nye, C., Macnamara, B., Charness, N. & Hambrick, D. (2019). The Impact of Domain-Specific Experience on Chess Skill: Reanalysis of a Key Study. *The American Journal of Psychology.* 132 (1): 27–38. https://doi.org/10.5406/amerjpsyc.132.1.0027

Burgoyne, A., Sala, G., Gobet, F., Macnamara, B., Campitelli, G., & Hambrick, D. (2016). The relationship between cognitive ability and chess skill: a comprehensive meta-analysis. *Intelligence* 59, 72–83. https://doi.org/10.1016/j.intell.2016.08.002

Calderwood, R., Klein, G., & Crandall, B. (1988). Time pressure, skill, and move quality in chess. *The American Journal of Psychology, 101*(4), 481–493. https://doi.org/10.2307/1423226

Campitelli, G., & Gobet, F. (2008). The role of practice in chess: A longitudinal study. *Learning and Individual Differences*, 18(4), 446–458. https://doi.org/10.1016/j.lindif.2007.11.006

CCRL 40/15 - index. (n.d.). Retrieved September 20, 2022, from https://ccrl.chessdom.com/ccrl/4040/

Charness, N., Krampe, R., & Mayr, U. (1996). The role of practice and coaching in entrepreneurial skill domains: An international comparison of life-span chess skill acquisition. *In K. A. Ericsson (Ed.), The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games* (pp. 51–80). Lawrence Erlbaum Associates, Inc.

Charness, N., Tuffiash, M., Krampe, R., Reingold, E., & Vasyukova, E. (2005). The Role of Deliberate Practice in Chess Expertise. *Applied Cognitive Psychology*, 19(2), 151–165. https://doi.org/10.1002/acp.1106

De Groot, A. (2008). *Thought and choice in chess*. Amsterdam University Press.

Engqvist, T. (2016). *Chess Strategy for Kids*. Gambit Publications Ltd.

Frank, A. (2011). *Chess and aptitudes*. Lulu.com.

Fuentes-Garcia, J., Pereira, T., Castro, M., Santos, A., & Villafaina, S. (2019). Psychophysiological stress response of adolescent chess players during problem-solving tasks. *Physiology & behavior 209:112609*. https://doi.org/10.1016/j.physbeh.2019.112609

Gobet, F., Campitelli, G. (2007). The role of domain-specific practice, handedness, and starting age in chess. *Developmental Psychology*, 43(1), 159–172. https://doi.org/10.1037/0012-1649.43.1.159

Gong, Y., Ericsson, K., & Moxley, J. (2015). Recall of briefly presented chess positions and its relation to chess skill. *PloS one, 10*(3), e0118756. https://doi.org/10.1371/journal.pone.0118756

Grooten, H. (2017). *Chess Strategy for Club Players: The Road to Positional Advantage*. New In Chess; New 3rd edition.

Heisman, D. (2009). *The Improving Chess Thinker*. Mongoose Press.

Holding, D. (2021). Evaluating Chess Positions. In *The Psychology of Chess Skill*. Routledge.

Kilger, M. (2017). Talking talent: Narratives of youth sports selection. *Thesis for PhD*. doi: 10.13140/RG.2.2.28877.03047

Konchev, M. (2019). Big data, neural network and predictive analytics: application in the field of sport. *International scientific congress "Applied Sports Sciences" and Balkan scientific congress "Physical Education,*

Sports, Health" in Sofia, Bulgaria, 2019, NSA Press, Sofia, pp 393-397

Perotti, J., Jo, H., Schaigorodsky, A., & Billoni, O. (2013). Innovation and nested preferential Growth in Chess playing Behavior. *EPL (Europhysics Letters);* 104 (2013) 48005. https://doi.org/10.1209/0295-5075/104/48005

Pluss, M., Bennett, K., Novak, A., Panchuk, D., Coutts, A., & Fransen, J. (2019). Esports: The Chess of the 21st Century. *Frontiers in psychology*,10,156. https://doi.org/10.3389/fpsyg.2019.00156

Roring III, R. (2008). Reviewing Expert Chess Performance: A Production Based Theory of Chess Skill, *Dissertation Department of Psychology*, Florida State University

Sala, G., Gorini, A., & Pravettoni, G. (2015). Mathematical problem-solving abilities and chess. *SAGE Open* 5, 1–9. https://doi.org/10.1177/2158244015596050

Vollstädt-Klein, S., Grimm, O., Kirsch, P., & Bilalić, M. (2010). Personality of elite male and female chess players and its relation to chess skill. *Learning and Individual Differences*, 20(5), 517–521. https://doi.org/10.1016/j.lindif.2010.04.005

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STUDY OF COORDINATION ABILITIES AND THEIR RELATIONSHIP TO ANTICIPATION IN ATHLETES

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ABSTRACT
Coordination abilities are a set of human properties manifested in the training process and in competitive activity, which determines the success in the management of motor actions of different coordination levels (Lyach, 2002).
According to Anochin (1979), an anticipation is a particular form of "overtaking reflection", in which the image of the result of the action of its actual appearance (occurrence) is formed in the mind of man. Based on this statement, we will try to improve the performance of athletes.
Improving the results by choosing the right action according to the feedback received after the first attempt and focusing attention and actions on rational and pragmatic implementation, which we expect to improve results and reduce repetitions in the study of new actions. In our view, a way to achieve this goal would be through work to improve the anticipation capabilities of athletes.
The problem of anticipation in sports games is of utmost importance for achieving victory in the completion between offender and defender.
Coordination of movements is related to coordination with objects, people, animals, and machines, the behavior and movement of which are often unpredictable (Videv, 2015). In turn, anticipation produces skill-actions (respectively, counteractions) that are confidently carried out within a fraction of a second, called "improvisation", which is significantly increased by targeted multi-year preparation from childhood (7-8 years).
Based on everything so far mentioned, we decided to test the coordination abilities of athletes and, at the same time, see how they would act in subsequent situations similar to the previous one to improve their performance by applying their anticipation skills.
Our results point to our assertion that creating an image of your work and bringing anticipation actions into the implementation of performance, in this case, the implementation of various coordination exercises, would improve the performance of athletes.

Keywords: *single sports, team sports, sports realization, coordination, anticipation*

INTRODUCTION

Coordination abilities represent a set of human abilities used in the training process and in competitive activity, which determines success in managing motor actions with different coordination complexity (Lyakh, 2002).

According to Anokhin (1979), anticipation is a special form of "anticipatory reflection", in which the image of the result of the action (of its real appearance) is formed in the mind of a person.

According to Varbanov (2015), anticipation or anticipation itself (prediction) can be divided into two interrelated parts: motor abilities and game environment. He defined anticipation as an intellectual process because the results in his research were moderately positively related to general intelligence (the rate at which the mind processes information). The anticipation problem in sports games is extremely important to win in the duel between attacker and defender.

The successful anticipation (prediction, "reading") of the individual behavior and actions of the player with the ball from the defender is the alpha and omega of success in a specific game situation. This also applies to groups' and teams' actions and counteractions. We must immediately note that this problem applies with the same force to the opposing side (defender, group of defenders, team).

In our opinion, anticipation in sports games is an anticipatory creative, thought-motor action through which we can improve all the necessary qualities and abilities, and hence the final results.

According to a number of authors, muscle sensitivity occupies an important place in the overall motor act. They define it as a set of sensations that accompany every human movement, the movement of body parts, and their changes relative to each other. Success in the implementation of the activity is determined by the state and development of the visual, motor, and vestibular analyzer (Popov, 1980; Yordanov; 1972, Farfel, 1977). According to Varbanov et al. (2014), by means of the "movement" of thought, a certain action can be performed before the expected signal is given.

Movement coordination is related to coordination with objects, people, animals, and machines, whose behavior and movement are often unpredictable (Videv, 2015). On the other hand, anticipation gives rise to a skill - actions (or countermeasures) that can be confidently performed within fractions of a second, called impromptu (improvisation), which is significantly increased through targeted multi-year training from childhood (7-8 years).

It is important to build the ability to react in the following conditions:

- in which it is necessary to quickly organize adequate actions in unforeseen competitive circumstances.
- in which certain actions are played in advance to deal with unexpected situations.

It is based on everything presented here that we will try to improve the results of athletes in the so important coordination abilities by means of anticipatory actions in subsequent situations similar to the previous one.

METHODS

Improving the athletes' results by choosing the right action as a result of feedback received from them after the first attempt and directing attention and actions of the athletes to a rational and pragmatic attempt. Through this, we subsequently expect athletes to improve their results, and with these actions to reduce the repetitions in the learning of the new actions. In our view, a way to achieve this goal would be through working to improve the anticipatory abilities of athletes.

For this purpose, we selected four main coordination abilities - accuracy, balance, rhythm, and coordination in space, which are important in sports practice. For success, the motor actions performed in a specific situation are also important, which is related to an analysis of what is happening for which the coach is responsible. However, once the coach has given feedback, it is very important for the athlete to make sense of what the coach has told him and take correct and rational actions to get the most out of the situation. This, in turn, is related to anticipating the situation. This is the other goal we set for ourselves, by analyzing what is happening, the athlete to make a rational decision.

To realize the given goal, we selected 22 athletes and first-year students from the National Sports Academy. Half practice individual sports, and the other half practice team sports.

The research proceeded as follows. The various tests were explained and demonstrated. Students paid attention to the performance technique and options for improving the results. Students were allowed three attempts, and after each attempt, their actions were analyzed, and feedback was given to anticipate their reactions in the next attempt and counter them to improve performance.

The obtained data were processed by mathematic-statistical methods, as the main method, we used the Student's t-test for dependent samples to determine whether there was a real change in the results obtained in the subsequent attempts of the athletes.

RESULTS

Figure 1 presents a comparison between the obtained data of the tested athletes from the NSA at the beginning and at the end of the study. It is important to clarify that for the first three coordination abilities (accuracy, balance, and rhythm), the better results are the higher values (positive growth), while for the last coordination ability (coordination during locomotion), the better results are the lower values (negative increment).

It can be seen from the figure that in the four studied coordination abilities, the final result is better than the initial one. The biggest difference between the initial achievement and the final one is in the indicator examining rhythmic abilities (2.36 cycles) and orientation in space (1.51 sec).

In the first indicator measuring accuracy, the difference between initial and final achievement is insignificant (0.35 points). This difference according to Student's coefficient is random, and therefore, according to this coordination ability, we cannot say that students were influenced by the feedback and failed to build a better strategy to achieve better results.

The picture is similar for balance abilities. The resulting difference is small (0.58 sec.). It has not been confirmed with the required level of confidence. Therefore, on this metric as well, the students performed better, but we are not sure if this is due to them anticipating the environment and their body's reactions or simply having a higher score.

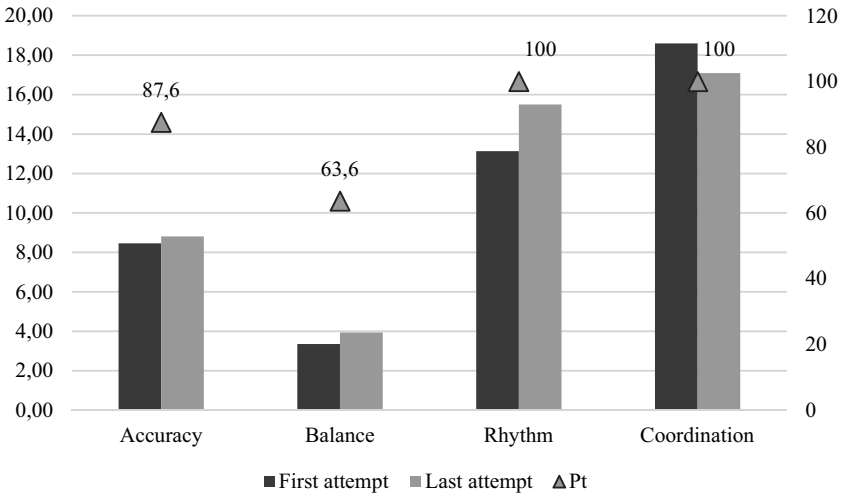

Figure 1. *Comparison of the results from the first and last attempt*

Rhythmic ability is the coordination ability in which the students achieved the best improvement after analyzing the performance. In this test, the obtained result is statistically significant. We could explain this by that that there is a greater field of corrective action in the execution of the individual cycles in the applied test.

With the last coordination ability, examining the coordination of movement, it is possible to analyze the trajectory of movement and the bending of the body and, from there to search and take shorter actions to achieve a better time. The students managed to do this by improving their scores by 1.51 seconds. This improvement in the time of completing the test is confirmed by the required confidence percent. Thus, we can say that this result is not accidental, and we can attribute it to a correct reading of the situation and improvement of the actions taken.

Figure 2 presents a comparison of the initial and final results of the athletes, whether they practice individual or team sports, in order to establish whether there are differences in the coordination and anticipation skills of the studied groups.

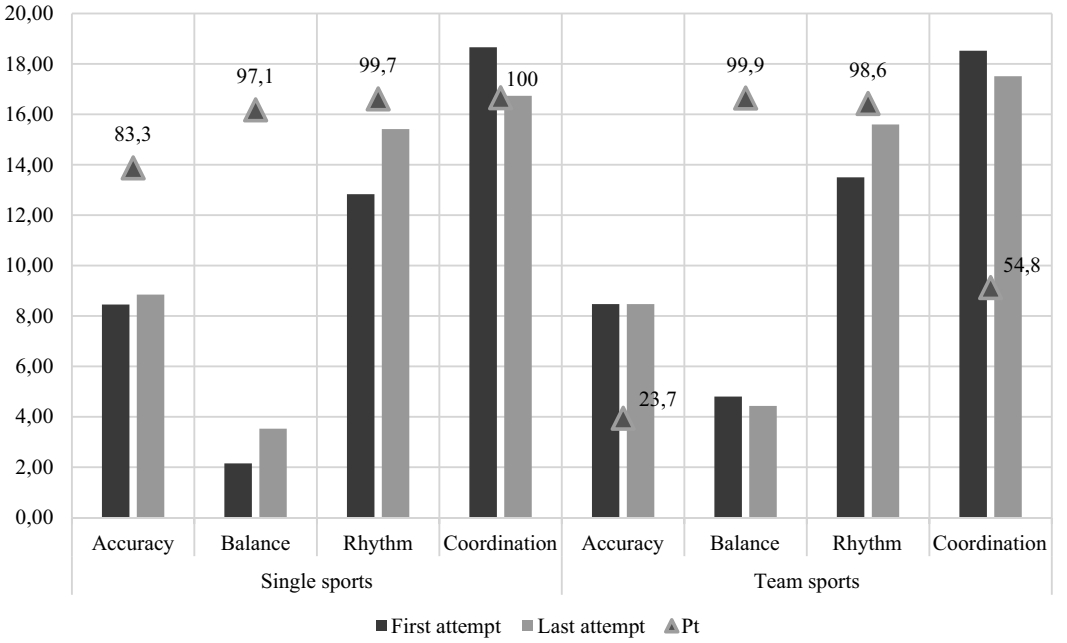

Figure 2. *Result of the single sports athletes and team athletes in the first and last attempt*

Figure 2 presents the picture of the study, it can be seen that there are differences between individual athletes and team ones. In individual sports in all four studies, athletes showed better understanding

and anticipation of the situation, which improved their performance. This improvement in their performance was confirmed in 3 of the four coordination tests which were performed – balance, rhythm, and coordination.

While the picture in team sports is different. In them, an improvement in the final result was observed in two of the four tested coordination abilities - rhythm and coordination. Only the result in rhythm was confirmed with statistical accuracy.

In the other two coordination abilities, accuracy and balance, the team athletes had worse results at the end of their study compared to the initial data. This deterioration is confirmed by the balance indicator, which tells us that the balance ability in team sports cannot be controlled by the athletes, and even has the opposite effect - it worsens.

DISCUSSION

Optimal performance in time-constrained and dynamically changing environments depends on making reliable predictions about future outcomes (Haris et al., 2022). In sporting tasks, performers have been found to employ multiple information sources to maximize the accuracy of their predictions.

As Buzsard (2022) says: "Elite sport offers a suitable setting to understand the ability to anticipate future events - a phenomenon that is central to animal life." According to his study, he finds that young athletes 9-11 years old cannot develop the ability of anticipation, while older ones at the age of 13 possess the ability to anticipate different tasks.

Active inference proposes that perception and action are underpinned by the organism's need to remain within certain stable states. To this end, decision-making approximates Bayesian inference, and actions are used to minimize future prediction errors during brain–body–environment interactions (Haris et al., 2022). Gained results in our study support our claim that creating an image and incorporating anticipatory actions into performance, in this case, performing various coordination exercises, would improve athletes' performance.

Athletes from individual sports better manage the situation and improve their results. While athletes practicing team sports only improve rhythm, their balance abilities deteriorate.

Of course, this is just the beginning of a much larger study that will try to prove the benefit of working to improve the anticipation of athletes and, through it, improve their overall performance in competitions.

Despite this welcomed progress, some fundamental questions and challenges remain to be addressed, including the (relative) contributions of visual and motor experience to anticipation, intraindividual and interindividual variation in gaze behavior, and the impact of non-kinematic (contextual or situational) information on performance and its interaction with advanced kinematics during the planning and execution of (re)actions in sport (Lofng, Cañal-Bruland, 2017).

Acknowledgments

In our opinion, the potential moment for improving the results lies in unraveling the "secrets" of anticipation in sports games and charting the way for its formation in the earliest childhood.

From what has been said so far, it can be summarized that the development of the athlete's mental functions is one of the important conditions for forming modern qualified competitors in sports games, where the ability to anticipate (and creativity) are crucial for victory.

REFERENCES

Anohin, P. (1979). *Izbrani trudai. Sistemni mehanizmi vishei nervno deiatelnost*., Izdatelstvo Nauka, Moskwa

Buzsard, T. (2022). On Learning to Anticipate in Youth Sport. *Sports Medicine,* German, Volume 52, Issue 10, Pages 2303 – 2314

Farfel, V. (1975). *Upravlenie dvijeniami v sporte*., Fizkultura i Sport, Moskwa.

Harris, D., Arthur, T., Broadbent, D., Willson, M., Vine, S., Runswick, O. (2022). An Active Inference Account of Skilled Anticipation in Sport: Using Computational Models to Formalise Theory and Generate New Hypotheses. *Sports Medicine*, German, Volume 52, Issue 9, Pages 2023 - 2038

Liah, V. (2002). *Sportivno-dvigatelni test dlia otsenki spetsificheski koordinatsionih sposobnosi futbolistov.* Teoria I praktika fizicheskoi kulturi, Moskwa

Lofng, F., Cañal-Bruland, R. (2017) Anticipation in sport. *Curr Opin Psychol*.; 16:6–1

Popov, N. (1980). Teoria I metodika na podbora v spor-

ta., Dissertation, ETNPFKS, Sofia.

Varbanov, I. (2015). *Savremeni tendentsii v handball.,* NSA press, Sofia.

Varbanov, I., Tishinov, O., Zsheliaskova-Koynova, Z. (2014). Study of anticipation in handball through interactive test, *Proceedings of 9th FIEP European Congress*, Sofia.

Videv, E. (2015). Preodoliavane na straha v ekstremni situatsii pri visochinni kaskadi, Dissertation, Sofia.

Yordanov, D. (1972). Izsledvane prostranstvenata diferenciovka v uchebno-vazpitatelnia protses po gimnastika., Dissertation, Sofia.

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COMPARISON BETWEEN BASIC RUNNING TRAINING TOOLS FROM SECOND LEVEL IN THE THREE MAIN VARIANTS FOCUSED PREPARATION FOR CLASSIC MOUNTAIN RUNNING

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ABSTRACT
The article presents research on running training tools in the preparation of runners specializing in classic mountain running. Distribution of basic running training tools for development of the second-level subfactors was analyzed in all of the three main variants of preparation – "Uphill", „Combined" and "Up and Downhill". Distribution of training tools can be seen per week in the framework of the macrocycle according to the purposefulness and the effect of their implementation relevant to the factors of the sport achievement. The research aims to analyze the use of the basic running tools from second level in all of the three main variants of purposeful preparation in classic mountain running. The subject of the research is the diversity of training tools used in the preparation of the mountain runners. The research object is the training and sport-racing activity in the mountain running. In the scope of the research, there are 29 training programs of mountain runners. Variation analysis has been used to analyze the results.
Average values of the training tools per week in the macro-structure were defined, according to the purposefulness of the effect of their implementation in the factors of the sport achievement.
Conclusions: 1) Main part of the running tools from second level are focused on the development of the sub-factor "pace endurance". 2) Differences in all of the three types of preparation show, that the sub-factor „pace endurance" is more significant, when the preparation is focused on racing in variants Up and downhill. 3) The volume and distribution of the running tools for the development of the sub-factors "strength endurance" and „speed-strength potential "in all of the three variants are approximately equal. 4) When the training in mountain running is directed to the variant "Up and downhill" we see an increased portion of the flat running with an intensity close to the one during the racing itself.

Keywords: *mountain running, off-road running, trail running, factors of the sport achievement, training methods*

INTRODUCTION

Mountain running is a sport that is becoming more and more popular all over the world. Mountain running competitions precede the ancient and modern Olympic Games (Kisyov, 2020). Despite its long history in athletics, mountain running is one of the newest disciplines. Mountain running is a sport for endurance, practiced in crossed terrenes, off-road, far from the city and the stadiums. In the theory and practice of the athletics, there are accredited models of the sport achievement where based on the theory for specialized diversity in the sport of prof. Mihail Bucvarov, the sport result is presented as a model of hierarchically ordered factors with special, diverse-specialized, and auxiliary meaning for achievement in the respective discipline (Bucvarov, 1982; Bucvarov, 2007). The model of achievement in mountain running prepared by us consists of main factors and hierarchically ordered subfactors, defining the level of the final sports result (shown in Figure 1) (Slavchev, Kisyov, 2016).

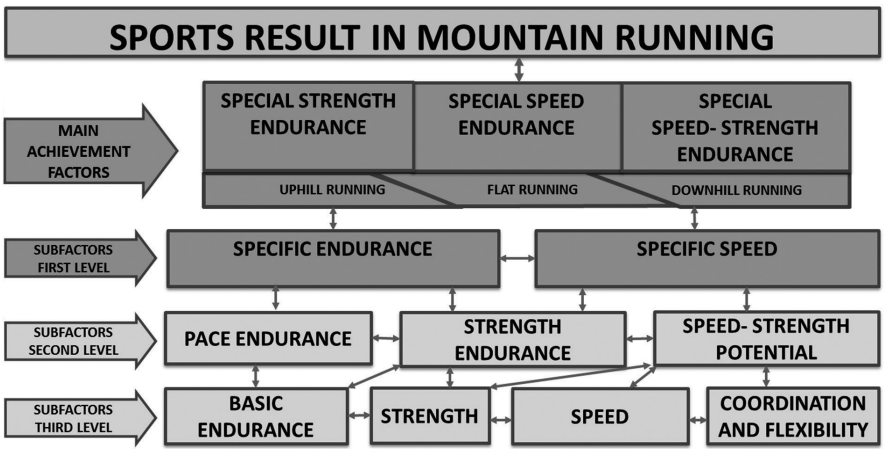

Figure 1. *Model of the sports result in mountain running.*

The difference in the motor activity between mountain running and the other long-distance running origins mainly in the specifics of the route. Major changes in the cinematic picture of the running are proved in the conditions of different in the steepness slopes, which are part of every route for mountain running (Kisyov, 2013; **K**isyov, 2014). That results in differences in the training methodology for mountain running in comparison with the methodology of flat running. We have found several scientific literature sources, which look at the variants of building and organization of the training process. (Zavuialov, Konovalov, 2010; Zavuialov, Konovalov, 2014). The structure, content, and characteristic of the different parts of the periodization of the preparation were investigated (Zavuialov, Konovalov, 2012; Zavuialov, Konovalov, 2013). The training methodologies in the preparation of runners from the world elite were reviewed. (Belotti, 2010; Dematteis, 2011; Gasperi, 2007; Manzi, 2007).

Contemporary trends in development of mountain running impose that the annual planning is under focused preparation, according to the specific conditions of the main competition. At the same time, the real sports calendar is very rich and diverse and offers many opportunities for manifestation. In the group of elite runners, three main variants of preparation can be distinguished:

1. First variant is where the preparation is focused only on a competition "Uphill".
2. Second variant, „Combined" is a purposeful preparation for both variants, respectively – "Uphill" and "Up and Downhill".
3. Third variant, where the preparation is focused only on competition "Up and Downhill".

The recent research is focused on the use of the training run, that is, developing factors „pace endurance", „strength endurance", and „speed-strength potential" (Table1) (Slavchev et al., 2017). We have researched the distribution of basic running training tools for development of the second-level subfactors, per week, in the framework of the macrocycle, according to the effect of their application with regards to the factors of the sport achievement in all of the three main variants of preparation – "Uphill", "Combined" and "Up and Downhill".

Table 1. *Basic running training tools from second level and their application regarding the factors of the sport achievement.*

Basic running training tools from second level	Achievement Factors
Control competitive running on leveled terrain	Pace Endurance
Rhythmic extensive (interval) running on leveled terrain	Pace Endurance
Continuous variative running (Fartlek) on leveled terrain	Pace Endurance
Intensive continuous running on leveled terrain	Pace Endurance
Extensive continuous running on leveled terrain	Pace Endurance
Aerobic developing running on leveled terrain	Pace Endurance
Running in burdened conditions (strength running)	Strength Endurance
Interval – rhythmic intensive running	Speed-Strength Potential
Repetitive running	Speed-Strength Potential

The research aims to analyze the use of the basic running tools from second level in all of the three main variants of focused preparation in classic mountain running - "Uphill", „Combined" and "Up and Downhill".

Research objectives are:

1. Defining the volume and distribution of the basic running training tools in macrostructure of the preparation and the application of those tools according to the achievement factors.
2. Comparative analysis of basic running training tools between all three main preparation variants.

METHODS

The methods used in the current research are literature review and statistical procedures. The scope of the research are 29 training programs of mountain runners. The object of the research is the training, and sport-racing activity in the mountain running, and the subject is the training tools, used in the preparation of mountain runners.

RESULTS

Results from the research of running tools for the development of the factors "pace endurance", „strength endurance", and „speed-strength potential" are shown in Table 2.

Table 2. *Weekly values of the distance in kilometers of the basic running tools from second level in variants of preparation. "Uphill" (U), „Combined" (C) and "Up and Downhill" (UD).*

Weeks	Basic running training tools from second level								
	„Pace Endurance"			„Strength Endurance"			„Speed-Strength Potential"		
	U	C	UD	U	C	UD	U	C	UD
1	2	3	4	0	0	0	0	0	0
2	4	5	5	0	0	0	0	0	0
3	5	6	6	1	0	0	1	1	1
4	6	5	5	2	1	1	2	2	2
5	5	5	7	1	1	1	3	1	1
6	8	10	10	1	2	2	2	3	3
7	8	12	12	2	3	2	4	3	3
8	11	5	7	1	2	2	4	2	2
9	4	5	5	3	2	2	3	4	3
10	6	4	6	2	1	1	2	3	3
11	8	7	7	1	0	0	3	4	4
12	4	10	12	0	0	0	1	3	3
13	6	13	13	0	0	0	3	0	0
14	5	10	10	0	0	0	3	0	0
15	7	14	14	0	0	0	4	0	0
16	6	7	8	0	0	0	3	0	0
17	7	10	10	0	0	0	2	0	0
18	4	5	8	0	0	0	0	3	3
19	11	6	6	0	0	0	0	4	4
20	12	12	14	0	0	0	0	4	4
21	5	5	7	0	0	0	0	2	2
22	4	10	10	0	0	0	0	0	0
23	8	13	15	0	0	0	0	0	0
24	6	11	11	0	0	0	0	0	0
25	6	3	4	0	0	0	0	0	0
26	2	5	5	0	0	0	0	0	0
27	3	6	6	0	0	0	0	0	0
28	5	2	5	0	0	0	0	0	0
29	2	1	4	0	0	0	0	0	0
30	2	7	7	0	0	0	0	0	0
31	1	2	3	0	0	0	0	0	0
32	2	2	2	0	0	0	0	0	0
33	1	1	1	0	0	0	0	0	0
34	2	6	6	0	0	0	0	0	0
35	1	2	3	0	0	0	0	0	0
36	2	0	2	0	0	0	0	0	0
37	3	0	0	0	0	0	0	0	0
38	3	1	1	0	0	0	0	0	0
39	2	0	0	0	0	0	0	0	0
40	1	2	2	0	0	0	0	0	0
41	4	3	3	0	0	0	0	0	0
42	1	0	0	0	0	0	0	0	0
43	4	2	2	0	0	0	0	0	0
44	4	1	1	0	0	0	0	0	0
45	3	1	1	0	0	0	0	0	0
46	1	4	4	0	0	0	0	0	0
47	1	2	2	0	0	0	0	0	0
48	1	1	1	0	0	0	0	0	0
49	2	2	5	0	0	0	0	0	0
50	1	18	18	0	0	0	0	0	0
51	1	1	3	0	0	0	0	0	0
52	1	2	4	0	0	0	0	0	0
Total	214	270	307	14	12	11	40	39	38

In all variants of preparation, training tools for the development of the factor „pace endurance“ are used mainly in the preparation period. On Figure 2 is visible, that during the whole year most often are alternated weeks with a higher volume and weeks with a lower volume of kilometers. The researched training programs show, that many of the mountain runners specializing in variants „Combined“ and “Up and Downhill”, have participated in a competition of half-marathon in the special preparatory and in the transition periods.

When the preparation is for variant “Uphill”, the weekly volume is 214 km, in variant „Combined“ is 270 km, and in „Up and Downhill“ reaches 307 km. It is visible that the volume of the training tools for „pace endurance“ is increased when the preparation is for running downhill.

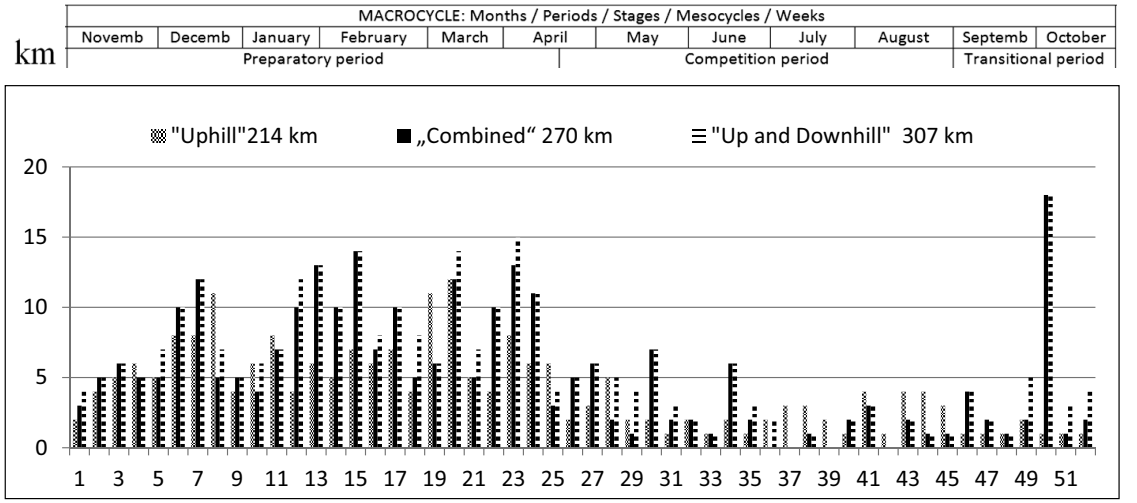

Figure 2. *In the frame of macrocycle on the abscissa is shown the weekly distribution of the kilometers from training tools for the development of the factor „pace endurance“ in all of the three main variants of preparation*

Running training tools for the development of the factor „strength endurance“ are used only in the general preparatory stage in all of the three variants, and in variant “Uphill” their volume is slightly bigger (Figure 3).

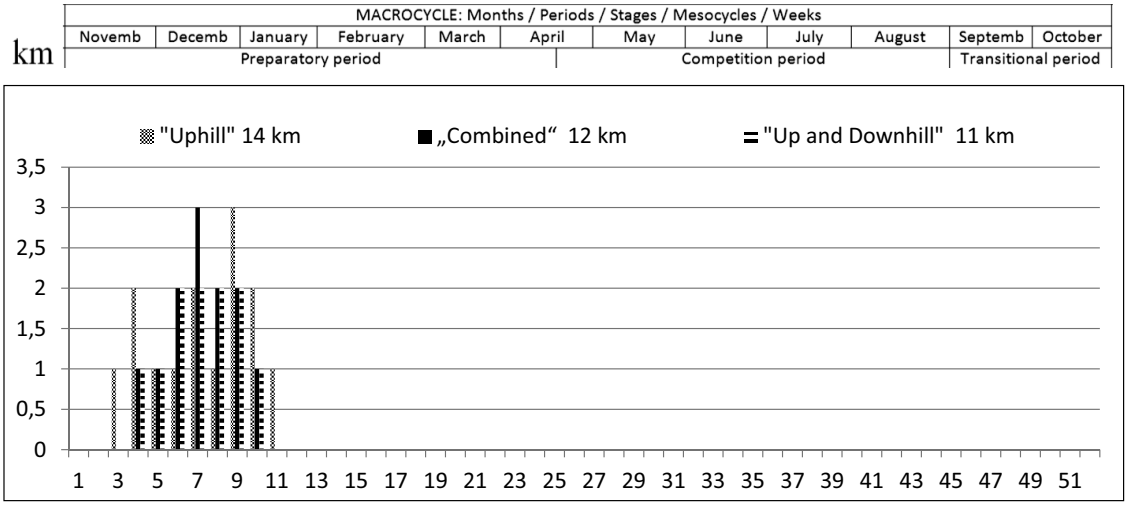

Figure 3. *In the frame of macrocycle on the abscissa is shown the weekly distribution of the kilometers from training tools for the development the factor „strength endurance“ in all three main variants of preparation*

For all three variants, the running that is developing the sub-factor „speed-strength potential“ is included in the preparation in the third week of the general-preparatory period and their volume is gradually increasing and reaches maximal values till the beginning of the special-preparatory period. Annual

volume in all of the three variants is approximately equal, but with different distributions. In variant "Uphill" it is distributed without interruption for 15 weeks till the middle of the special-preparatory period, while in variants „Combined" and "Up and Downhill" it is separated into two blocks – the first block consists of 10 weeks, after which there is an interruption of 5 weeks and follows a bloc of 4 weeks, which ends at the end of special-preparatory period (Figure 4).

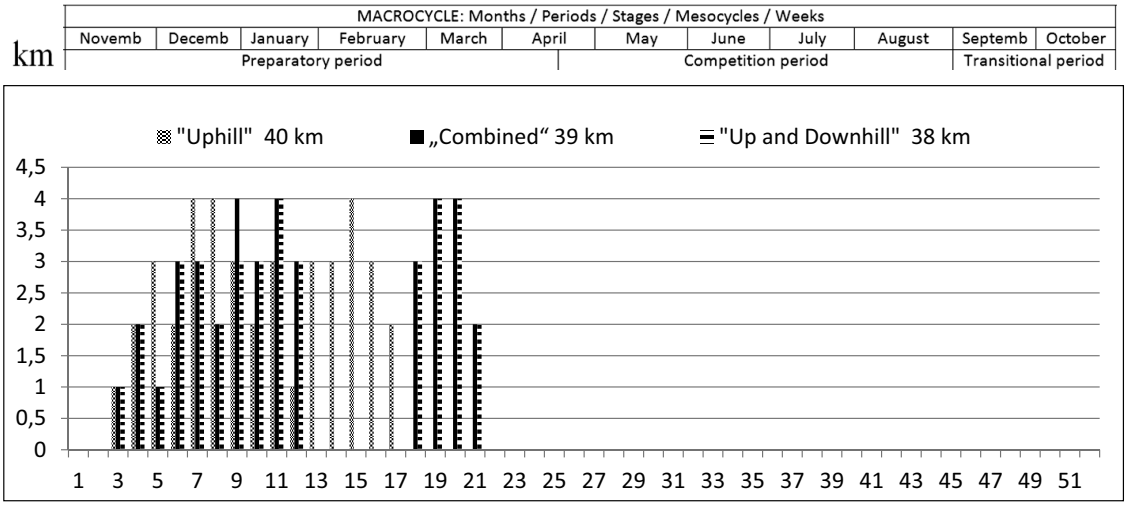

Figure 4. *In the frame of macrocycle on the abscissa is shown the weekly distribution of the kilometers from training tools for the development of the factor „speed-strength potential" in all three main variants of preparation.*

DISCUSSION

Mountain running is a comparatively new athletic discipline and there is still a lack of methodical literature, that covers thoroughly training tools in the preparation. We are one of the pioneers in the development of scientific concepts related to the training of mountain runners. Up to the present, there are no sufficient data for comparison of our results with the results of other similar researches.

Our research shows, that in all of the three variants of preparation, training tools for developing of sub-factor „pace endurance" are used mainly in the preparation period, with the biggest volume in the special preparation period. The main part of the running tools from the second level are directed to the development of the sub-factor „pace endurance". Differences in the three types of preparation show, that the sub-factor „pace endurance" is more significant, when the preparation is directed to racing in the variant "Up and Downhill". In that variant, the running volume of tools developing pace endurance are with approximately 30 percent more if compared with variant "Uphill".

Running tools for developing of sub-factor „strength endurance" are used only in the general preparation stage of the training in all of the three variants.

The annual volume of running that is developing the sub-factor „speed-strength potential" in all of the variants is approximately equal, but has a different distribution. In variant "Uphill" it is distributed without interruption, until in variants „Combined" and "Up and Downhill" it is divided into two blocs.

CONCLUSIONS

Based on the analyses of the research it can be concluded that:

1. Main part of the running tools from second level are focused to the development of the sub-factor "pace endurance".
2. Differences in all three types of preparation show that the sub-factor „pace endurance" is more significant when the preparation is focused on racing in variant Up and downhill.
3. The volume and distribution of the running tools for developing the sub-factors "strength endurance" and „speed-strength potential "in all three variants are approximately equal.
4. When the training in mountain running is directed to the variant "Up and downhill" we see an increased portion of the flat running with an intensity close to the one during the racing itself.

REFERENCES

Belotti. V. (2010). *Training prior to winning silver at the World Mountain Running Championships (uphill only) in Kamnik, Slovenia*. Retrieved 2012 from www.moun-

tainrunning.net/training/Valentina%20Belotti%20training%202010.pdf

Bucvarov, M. (1982). *Raznoobrazie na specialnata trenirovka.* Sofia: Medicina i fizkultura.

Bucvarov, M. (2007). *Specializirano raznoobrazie w lekata atletika.* NSA: PRES.

Dematteis, M. (2011). *Training prior to winning bronze at the World Mountain Running Championships (up and down) in Tirana, Albania*. Retrieved 2012 from www.mountainrunning.net/training/Martin%20Dematteis%20training%202011.pdf

Gasperi, M. (2007). *Training prior to winning the World Mountain Running Championships (up and down) in Ovronnaz*, Switzerland. Retrieved 2012 from www.mountainrunning.net/training/Marco%20De%20Gasperi%20training%202007.pdf

Kisyov, K. (2013). Kinematichna harakteristika na disciplinata planinsko bqgane v zavisimost ot razlichnite nakloni na traseto. *Leka atletika I nauka, 1 (13), 113 – 119*

Kisyov, K. (2014). Kriterii za kategorizaciq na trasetata za planinsko biagane. *Leka atletika I nauka, 1 (14), 30-38*

Kisyov, K. (2020). *Poqva, razwvitie I harakteristika na planinskoto bqgane. Sofia.*

Slavchev, A., Kisyov, K. (2016). Model na sportnia rezultat v planinskoto bqgane. *Leka atletika I nauka, 1 (16), 62-65*

Manzi, E. (2007). *Training specific to up and down mountain races: triangular fartlek*. Retrieved 2012 from www.mountainrunning.net/training/Triangular%20fartlek%20-%20Emanuele%20Manzi.pdf

Slavchev, A., et al., (2017). Classification of the training methods in mountain running. *Research in Physical education, Sport and Health. 1 (6), 37-42*

Zavuialov, K., Konovalov, V. (2014). Variantov organizacii specialnoi podgotovki. *Gornui beg, (10),10-14*

Zavuialov, K. (2010) Osobenosti postroenia trenirovuchnago procesa v gornom bege. *Omskii naucnui vestnik, 6 (92), 182-191*

Zavuialov, K. (2012). Struktura soderjanie trenirovucnuih mikrociklov etapa specialnui podgotovki u begunov vuisokoi kvalifikacii. *Omskii naucnui vestnik 4 (111), 250-259*

Zavuialov, K. (2013). Modelnie harakteristiki trenirovuicnih mezociklov sportsmenov, specializirushsia v gornom bege. *Omskii nauchnui vestnik, 6(82), 163-171*

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ANALYSIS OF THE TECHNICAL ACTIONS OF WRESTLING COMPETITORS, EUROPEAN CHAMPIONS FROM WARSAW - POLAND 2021

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ABSTRACT
The effectiveness of a given technique is the most expedient way to achieve high athletic performance. The technique is defined as a relatively indivisible and integral expression of sports training, which is characterized by specific quantitative and qualitative characteristics for the rationality and content of the movement. The study aimed to determine and analyze the technical actions of the champions, as well as their basic crown holds, grips, and movements (in contact and from a distance) on the mat of the European Wrestling Championships for Women, Warsaw - Poland 2021 in the categories 50 kg, 53 kg, and 76 kg. Methods: 3 female athletes were analyzed in the study. Their ages ranged from 28 to 31 years, and the average age of the studied group was 29 years. The sports career of the female athletes lasted 22 years (± 3 years). Video analyses by category were performed using the Internet platforms YouTube and UWW of female athletes to analyze the technical actions. In the results obtained, a basic crown holds, grips and movements (in contact and from a distance) on the mat were revealed that would be useful to freestyle wrestling professionals.

Keywords: *female wrestlers, analysis of technical actions, European Champions*

INTRODUCTION

The analysis of technical actions after each competition is a very important part of the athlete's preparation. The following are observed and practiced: the haste or delay of the technical action, the incorrect application, breaking of the grip, and insufficient tightness in the grip of one or both legs. To execute a motor action, the correct training methodology and its improvement are needed. The hallmark and indicator of the quality of technique are determined by efficiency. The efficiency of a given technique is the most expedient way to achieve high athletic results. The technique is defined as a relatively indivisible and integral expression of sports training, which is characterized by specific quantitative and qualitative characteristics of the rationality and content of the movement.

The technical-tactical skills of a female wrestler are the set of holds, defenses, and counterholds for conducting the competitive wrestling match and deciding its outcome. The technical armament of a female wrestler depends on her anatomical-morphological and psychological characteristics and on the degree of development of her motor qualities (Petrov, 1978). The technique of wrestling is a complex range of skills applied by both competitors during the bout. It is not possible for a female competitor to realize an achievement without possessing a purposeful and effective technique. Irrespective of the rules of wrestling, technical female wrestlers are always the winners of the honors and that is why the improvement of technique has the largest share in the preparation for various competitions. It is an inexhaustible matter that never ends and is subject to constant development (Iliev, 2015).

Stanev (2011) notes that preparation for an offensive action should be no more than 15-20 seconds when the match is lost and of greater duration when leading in the score with various holding holds in the stance. It is imperative to apply the technique in the stance for as short a time as possible because this reduces the attack's ability to apply defenses and counter grips. On the ground, the preparation time when the opponent has assumed a stable position is much greater, especially for holds with a more complex coordination structure. The structure of a competitor's technical potential and effectiveness is determined by the rules currently in force. Timely adaptation is a guarantee of success on the domestic and international mat.

In wrestling, there is a variety of technical actions and combinations that are difficult to define. However, the application of certain techniques by a given wrestler/wrestler is significantly less. Petrov, Makaveev (1989), Kirov, Stanchev, Berberov, Dimitrov (1993) determined that based on biomechanics, logic, and methodology, the grip contains the following main phases of performance: preparatory phase, main phase, and final phase.

The main segments of technical mastery are the different wrestling stances (high, medium, and low stances), the movement on the mat, and the different grips and ranges during learning, technique refinement, training, and competition bouts. Each competitor is required to be able to make good grips and ranges on her opponent's arm and head, arm and neck, effective grips and ranges on one and both arms of her opponent, and ranges on her opponent's body on the ground for an effective score of points and tucks. Movement on the mat with changing grips and ranges does not allow the opponent to execute a grip, switching from one grip to another grip, creating an advantageous situation to apply holds, defenses, counter grips, etc. The ability to implement advantageous situation for attacking and holding actions makes training more effective and targeted to achieve high results in international competitions for women later (Iliev, 2015).

Dominance over the opponent is achieved through superior technique and tactics - imposing comfortable holds, defending and counter attacks, executing crown holds, false moves, and very good tactical preparation. Equally important are power pressure, speed, and high pace during the fight - endurance (Iliev, 2016).
As a basis for the training of the technique is taken the original technique, according to the anthropometric, morphological, mental, and tactical abilities of a given athlete with the search for new connective actions and enrichment with different tactical preparations (Tarakanov, 2010). Achievement is not only the quantitatively reported result but the success in sports competition in general. The system for reporting this success may be various (subjective, objective, quantitative, rank, etc.), but the technique is directly or indirectly involved in this reporting (Brogley, 1977).

The study aimed to determine and analyze the technical actions of the champions, as well as their main crown holds, grips, and movements (in contact and from a distance) on the mat of the European Wrestling Championships for Women, Warsaw – Poland, 2021 in the categories 50 kg, 53 kg, and 76 kg.

METHODS

Three female athletes were analyzed in this study. Their ages ranged from 28 to 31 years, the mean age of the study group was 29 years. The sports career of the female athletes lasted 22 years (±3 years).
To analyze the technical actions, video analyses were made by category through the YouTube and UWW internet platforms of the female wrestlers in their Olympic categories, champions of the 2021 European Championships in women's freestyle wrestling.
Mathematical and statistical data processing was performed and processed using Microsoft Office Excel 2016.

RESULTS

Category 50 kg.

The 50 kg category (Table 1) is Olympic, and 10 women participated. The gold medal was won by Maryia Stadnik (Azarbaijan).

Table 1. *Technical-tactical profile of Maria Stadnik (Azarbaijan)*

Technical actions from stand			**Technical actions on the ground**		
	Number of performances	**Points won**		**Number of performances**	**Points won**
Knockdown with log hold	2	8	Carrying over „bridge“ - to the left	1	2
Knocking down with right ankle span and passing behind	1	2			
Knockdown with left leg reach and pass behind	1	2	Passivity	1	1
Take down with right leg hold and pass behind.	1	2			
Taking off with arm and head covering from above (Halter) and passing behind	1	2			
Takedown with right leg grip and pass behind	2	4			
Pushing out of the area	5	5			

Pronounced right stance, fought from a distance. Basic grip - takedown with log hold; Parry - "carry across bridge".

Mariya Stadnik's wrestling matches total 3: Win by Fall (Pinning the opponent) - none, wins by Technical superiority - 1 and 2 wins end by earned points. The total time of all her wrestling matches is 15:50 min. Points won are 28. Points lost - 6: 4 pts. belt throw; 2 pts. takedown with right hand grip and passing behind.

53 kg category.

The 53 kg category (Table 2) is Olympic and 17 women took part. The gold medal was won by Olga Khoroshavtseva (Russia).

Table 2. *Technical-tactical profile of Olga Khoroshavtseva (Russia).*

Technical actions from the stand			Technical actions on the ground		
	Number of performances	**Points won**		**Number of performances**	**Points won**
Knockdown with neck hold and varied leg	1	4	Win by Fall (Pinning the opponent) after the Rear Suplex hold	1	
Take down with outside grip on left hand passing behind	1	2			
Take off with left ankle grip with head on inside	1	2	Challenge	1	1
Pulling down with arm and head cover on top (Halter) and passing behind	1	2	Passivity	1	1
Pulling down and passing behind	2	4			
Throw over the chest with a rear wrap (Rear Suplex)	1	2			
Left leg protection and passing behind	1	2			

Right stance, her wrestling is contact - right hand on the neck and holding the wrist with the left. Basic grapple - takedown with outside left-hand grip, takedown with neck hold and varied ankle holds, from the Bottom Position - multiple attempts - cross-legged roll.

Olga Khoroshavtseva's total number of wrestling victories is 3: wins by Fall (Pinning the opponent) - 1, wins by Technical superiority – none and 2 wins ending on points. The total time of all matches is 12:51 min. The points won are 20. Points lost - 0:

76 kg category.

The 76 kg category (Table 3) is Olympic and 14 women participated in it. The gold medal was won by Epp Maee (Estonia).

Table 3. *Technical-tactical profile of Epp Maee (Estonia)*

Technical actions from the stand			Technical actions on the ground		
	Number of performances	**Points won**		**Number of performances**	**Points won**
Left leg defense and passing behind	1	2	Carrying over the bridge - left and right	2	4
Right leg protection and passing behind	1	2			
Right-hand pull-up	1	2			
Pushing out of the zone	5	5			

A right-hand stands up, fighting at a distance. Basic grapple - takedown with right-hand pull. From the ground position - carry through "bridge" - left and right.

Estonian Epp Maee's total wrestling fights are 3: wins by Fall (Pinning the opponent) - none, wins by Technical superiority - 1 and 2 wins by points earned. The total time of all wrestling matches is 15:57 min. The points won are 15. Points lost – 1 and 1 points for passivity.

DISCUSSION

Through the platform of United World Wrestling (UWW), an analysis of the three female wrestlers, champions of the European Wrestling Championships in Warsaw, Poland 2021, was made, showing that all three wrestlers have won quotas for the Olympic Games in Tokyo. As Mariya Stadnik from Azerbaijan, 50kg category, placed third and won the bronze medal, Olga Khoroshavtseva from Russia, 53kg category, dropped out in the eighth finals, and Estonian wrestler Epp Maee, 76kg category, lost in the quarterfinals from Japan's Hiroe Minagawa, who subsequently failed to make it. It was found that in the remaining categories of the champions from the European Championships in Warsaw, Poland 80% of them have won quotas for the Olympic Games.

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CONCLUSION

From the analysis of the athletes' technique, it can be seen that the most commonly used techniques from the stance are: knockdown with head entry to the legs from the outside, inside, and both feet and ankles; takedown with an outside grip on the left or right hand.

From the group of throws - the highest number of points earned is observed from the grip: throwing across the chest with covering the log from behind (Rear Suplex); belt throw.

A large percentage of the technical action was taken off the halter and passing from behind - with a higher percentage in the 76 kg. weight class.

Pushing out of the zone is observed in almost all categories.

The technical actions used from the ground are: carrying over a bridge, in the 53 kg. category a push is observed after the execution of the "Rear Suplex" hold.

In the results obtained, basic crown holds, grips, and movements (in contact and from distance) on the mat were revealed, which would be useful to freestyle wrestling specialists.

REFERENCES

Brogli, Ya. (1977). *Statisticheski metodi v sporta*. Sofia, ECNPKFKS. // Брогли, Я. (1977). Статистически методи *в* спорта. София, ЕЦНПКФКС.

Iliev, I. (2015). *Metodika na podgotovkata po borba pri jeni i devoiki,* Dis. trud. // *Илиев*, И. (2015). Методика на подготовката по борба при жени *и* девойки. Дис. труд

Iliev, I. (2016). *Optimizirane nivoto na skorostno-silovata izdrajlivost v otdelnite mezocikli v sferata na jenskata borba. Naychna konferenciq "Predizvikatelstva i perspektivi pred sportnata nayka",* katedra "Tejka atletika, boks, fehtovka I sport za vsichki", Sofia 2016, s. 68-73 // *Илиев*, И. (2016). Оптимизиране нивото на скоростно-силовата издръжливост в отделните мезоцикли в сферата на женската борба. Научна конференция „Предизвикателства *и* перспективи пред спортната наука", „Специфика на подготовката *в* различните спортни дисциплини", катедра „Тежка атлетика, бокс, фехтовка и спорт за всички", София, 2016, с. 68-73.

Makaveev, O. (1989*). Zakonomernosti pri zahvatite v svobodnata borba*. Nauchni trudove na VIF, t. 29, kn. 2., pp. 201. // Макавеев, О. (1989). Закономерности при захватите *в* свободната борба. Научни трудове на ВИФ, т. 29, кн. 2, с. 201.

Petrov, R., Kirov, P., Stanchev, N., Makaveev, O., Dimitrov, N., Berberov, N., Stavrev, I., Stanchev, N., (1993). *Svobodna i klasicheska borba*, Sofia. // Петров, Р., Киров, П., Станчев, Н., Макавеев, О., Димитров, Н., Берберов, Н., Ставрев, И., Станчев, Н. (1993). Свободна *и* класическа борба, София.

Petrov, R. (1978). *Usavarshenstvane tehniko-takticheskoto maistorstvo na boreca*, MiF, S. // Петров, Р.

(1978). Усъвършенстване технико-тактическото майсторство на борeца, МиФ, С.

Stanev, S. (2011). *Svobodna borba za jeni*. // Станев, С. (2011). Свободна борба за жени.

Tarakanov, B. (2010). Pedagogicheski aspekti podgotovki jenshtin, zanimaushtihsq sportivnoi borioboi. *Sp. Teoriya i praktika fizicheskoi kulturii*, br. 6. // Тараканов, Б. (2010). Педагогические аспекти подготовки женщин, занимающихся спортивной борьбой. сп. Теория *и* практика физической культурьи, , бр. 6.

United World Wrestling, (2021). Results Women's wrestling. Retrieved August 01 - 07, 2021 from https://uww.org/event/tokyo-2020?section=results#

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STUDY OF STRENGTH TRAINING IN FEMALE 400 m SPRINT EVENT IN AGE ASPECT

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ABSTRACT
Studying the different aspects of 400 m sports preparation is a key factor for the proper development of sports results. Strength training is one of the main pillars of sprint running. The object of the study is sports training of athletes in the 400 m sprint, and in particular strength training. The subject is the content and volume of the annual preparation for different age groups. We used the following methods: sports-pedagogical and technical-tactical analysis of athletes; interviews with coaches and athletes; Case-study analysis; Mathematical and statistical methods. A total of 58 macrocycles were analyzed: 16 macrocycles for under 18 years, 20 macrocycles for under 20 years, 22 macrocycles for women. We made a classification of the used exercises according to the main factors of sports achievement. We found a difference in the variety of exercises applied for different age groups. Girls under 18 years have a larger set of auxiliary exercises for strength training compared to women who have less variety but increased tonnage in weight training. We established minimum, maximum and average volume values of the various means in macro-, meso- and microcycles, according to age groups. In conclusion, we can note the lack of current scientific and methodological developments related to the selection and application of a specific volume of different means during stages of sports preparation, motivated us to bring out our study and represent relevant information for the volume and diversity of used athletic means. The dynamic development of track and field preparation has to constantly update, change and improve. The study of preparation variations that are known to be successful and efficient brings valuable theoretical information that can be used in the future. Systematization of data from the practice and indication of the basic volumetric parameters of training means for strength training in the 400 m run, will help for more purposeful preparation.

Keywords: *strength, sprint, annual preparation, women*

INTRODUCTION

Sports preparation in track and field complex and multipurpose system which main aim is to prepare the athlete for the best possible result, at the right time. Each age group has different tasks in preparation, but all of them must lead to gradual technical improvement with a good level of physical abilities. All the different components must be included very carefully and must fulfill the individual characteristics of each athlete.

In the specialized methodical literature, according to individual authors, there is a great terminological diversity of factors on which, the sport result for 400 m depends on (Gadev, 1996; Buchvarov, 1991). Strength is a key factor for all sprint events, of which the 400 m dash is included. Also, strength training is part of all stages of preparation, but with different approaches and means. Development stages of an athlete, even for 400 m sprinters pass through combined events, which are mandatory for girls and boys under 14 years (Gutev, 2013; Gutev, Njagin, 2012). Vittori (1991) identifies the fundamental functional requisites for success in this event as a combination of strength, speed and endurance, plus an appropriate effort distribution (Miguel, 2004). That is why practical data from 400 m training sessions can be deemed as a model to follow (Slavchev, 1999; Dimitrov, 1987, 2003).

Increasing demands on sports training require more and more attention to be given to every single aspect of the training process. Achieving good results would be possible only if working in the right direction during all stages of multi-year training. That is why it is necessary to reveal the narrow specifics of the preparation in the 400 m discipline, with the data extracted from the practice being an exact corrective and a kind of exemplary model.

Aim and objectives of the study

The aim of the study is the enrichment of sport theory with specific data brought out from practice, related to the disclosure of volume values of strength drills for different age groups. The main objectives are: Disclosure of the main training drills for each age group. Establishing the absolute values in the smaller structural units in the annual macrocycle.

METHODS

The studied data is from detailed training diaries from athletes and coaches. All athletes specialized in 400 m dash, which indicates specific similarities in the training process and used athletic exercises. We analyzed the included strength exercise. We dif-

ferentiate them according to M. Buchvarov's theory of specialized variety, which divides exercises into special, specialized, and auxiliary drills. We mainly deal with the auxiliary drills used to improve the strength of the female runners. The data is separated into 3 age groups: under 18, under 20, and women. A total of 58 macrocycles were analyzed: 16 macrocycles for under 18 years; 20 macrocycles for under 20 years; 22 macrocycles for women. After data systematization and analysis, we managed to establish the range of volume for all exercises and their distribution through the structural blocks of the annual preparation.

We used the following methods: sports-pedagogical and technical-tactical analysis of athletes; interviews with coaches and athletes; Case-study analysis; Mathematical and statistical methods.

Table 1. *Exercise group types*

Type of exercise	Measure unit
Exercise with external resistance and weights	Tone
Horizontal and vertical jumps	Number of repetitions
Basic exercise (crunches, push-ups, pull-ups, resistance bands, medicine balls)	Number of repetitions
Stair climbing	Number of sessions
Games	Number of sessions

All respondents of the research were briefed about the aim of the study and informed consent was taken from each one of them, incl. the parents of the respondents under 18 years of age.

RESULTS

The used drills for strength may relate to a different factor of sports performance for 400 m (figure 1), depending on the number of repetitions and the speed of performance. For instance, if the athlete makes 5 to 8 quick horizontal jumps, they would relate to the factor of maximal speed. And if an athlete makes 20 to 30 jumps with an optimal speed of execution, this can relate to special endurance. Our starting point is M. Buchvarov's theory of specialized variety. Most of the strength exercises for 400 m are classified as specialized and auxiliary. Specialized exercises are close to the form and biomechanical characteristics of the competition event. And auxiliary exercises differ from form and biomechanical traits.

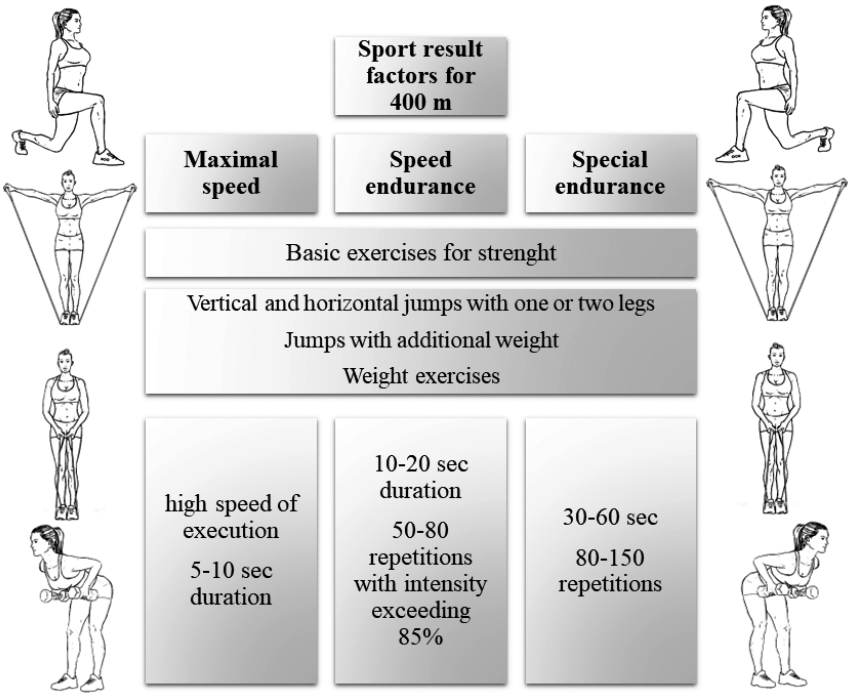

Figure 1. *Basic specialized and auxiliary exercises according to the sport factor*

Table 2. *Number of drills for the studied age groups*

age group	U18	U20	women
number of exercises	52	43	40
average of 45 different drills			

When we look at Table 2, we can note that younger runners tend to have more variety of drills. And from moving to the adolescent age group, the number of drills is dropping. We can explain this fact with the specifics of each group. For athletes under 18 and 20 years, the use of many basic exercises is common because they are still in the stage of discipline orientation. As for women, which are in the stage of high sports performance the usage of drills is narrow and specialized.

Different exercises may have a different effect depending on the way, and the number of repetitions and sets done in the training. The drills we analyzed in the current study can target not only strength but also speed, power, mobility, and coordination, but each separate drill can relate to strength improvement. And strength for 400 m has a big influence on sports performance. Of course, everything has to be in moderation, because a great volume of strength exercises can lead to stiffness, which is not desirable in the last 80-150 of 400 m run, where relaxation is needed. The following tables represent the main data of our study. We point out the range for each particular mesocycle, for the three age groups. Also, the mean value is indicated in the tables. This information would give coaches a substantial base for planning their athlete's preparation. Besides, we can note that the volumetric values of the exercises have complied with the main principles of sport preparation. We can see the gradual increment of volume from basic mesocycle to special preparatory. And in the competition mesocycle, we can see the expected drop in training load. We observe the increment of load from younger age groups to senior age groups.

Table 3. *Number of jump repetitions during the annual preparation (number of repetitions)*

First Macrocycle U18						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**IX**	**X**	**XI**	**XII**	**I**	**II**
Xmin	167	260	304	396	271	237
Xmax	450	644	908	1018	686	584
$\bar{x}$	209	487	532.9	638	392	404.5
Second Macrocycle U18						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**II/ III**	**IV**	**V**	**VI**	**VII**	**VIII**
Xmin	237	239	284	259	200	
Xmax	584	884	731	960	505	
$\bar{x}$	405	462	466	566	330	

First Macrocycle U20						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**IX**	**X**	**XI**	**XII**	**I**	**II**
Xmin	179	761	399	317	382	808
Xmax	679	1352	700	775	2181	1206
$\bar{x}$	405	1069	506	492	1021	995
Second Macrocycle U20						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**II/ III**	**IV**	**V**	**VI**	**VII**	**VIII**
Xmin	307	409	264	117	45	45
Xmax	1199	726	710	299	100	100
$\bar{x}$	634.15	556.5	415.3	197	66.4	66.4

First Macrocycle Women							
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**IX**	**X**	**XI**	**XII**	**I**	**II**	**III**
X min	273	169	298	408	263	340	462
Xmax	1623	734	1656	1100	1151	1076	1765
$\bar{x}$	747	544	664.4	641.5	560.7	736.6	1199
Second Macrocycle Women							
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Competition mesocycle	Competition mesocycle
month	**II/III**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
Xmin	230	271	266	245	275	1751	1749
Xmax	1412	1391	540	470	300	7340	5878
$\bar{x}$	647	516	398	332	287	3894	3380

Table 4. *Training with weight during the annual preparation (tone)*

First Macrocycle U18						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**IX**	**X**	**XI**	**XII**	**I**	**II**
Xmin	5.78	8.87	11.75	11.76	10.31	7.68
Xmax	9.59	24.76	26.64	36.76	32.00	17.69
$\bar{x}$	7.68	15.90	18.04	26.31	19.43	12.05
Second Macrocycle U18						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**II/ III**	**IV**	**V**	**VI**	**VII**	**VIII**
Xmin	10.50	6.80	11.21	8.85		
Xmax	52.02	27.58	30.85	16.70		
$\bar{x}$	23.44	16.28	20.54	12.27		

First Macrocycle U20						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**IX**	**X**	**XI**	**XII**	**I**	**II**
Xmin	12.68	11.12	7.96	15.97	4.05	7.02
Xmax	25.53	46.90	46.20	34.03	19.32	35.01
$\bar{x}$	19.10	25.56	23.21	24.12	10.13	17.27
Second Macrocycle U20						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**II/ III**	**IV**	**V**	**VI**	**VII**	**VIII**
Xmin	19.61	16.11	8.01	4.15	6.50	1.10
Xmax	53.26	38.88	27.28	13.30	6.50	13.34
$\bar{x}$	32.64	25.20	16.22	8.65	6.50	4.89

First Macrocycle Women						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**IX**	**X**	**XI**	**XII**	**I**	**II**
Xmin	6.30	8.13	11.86	13.83	7.51	10.00
Xmax	17.31	34.06	52.79	56.67	35.33	43.78
$\bar{x}$	8.73	16.75	25.57	25.54	16.40	19.29

Second Macrocycle Women						
mesocycle	Basic Preparatory	Special Preparatory	Special Preparatory	Precompetition mesocycle	Competition mesocycle	Recovery +basic
month	**II/ III**	**IV**	**V**	**VI**	**VII**	**VIII**
Xmin	6.44	11.40	8.24	6.36	6.17	7.35
Xmax	51.30	41.85	31.93	20.63	29.10	13.30
$\bar{x}$	18.49	19.57	14.14	12.05	15.86	11.13

The following figures show the volume of the strength exercises for the first and second macrocycles and the eventual annual volume. Bigger loads are shown in the first macrocycles, which is due to the long preparation period.

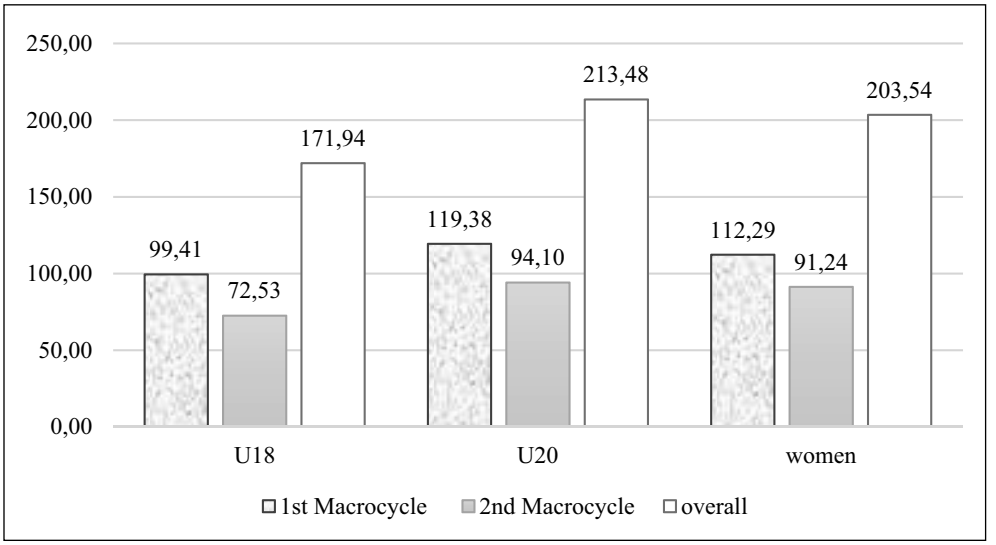

Figure 2. *Average volume of weight training (tone)*

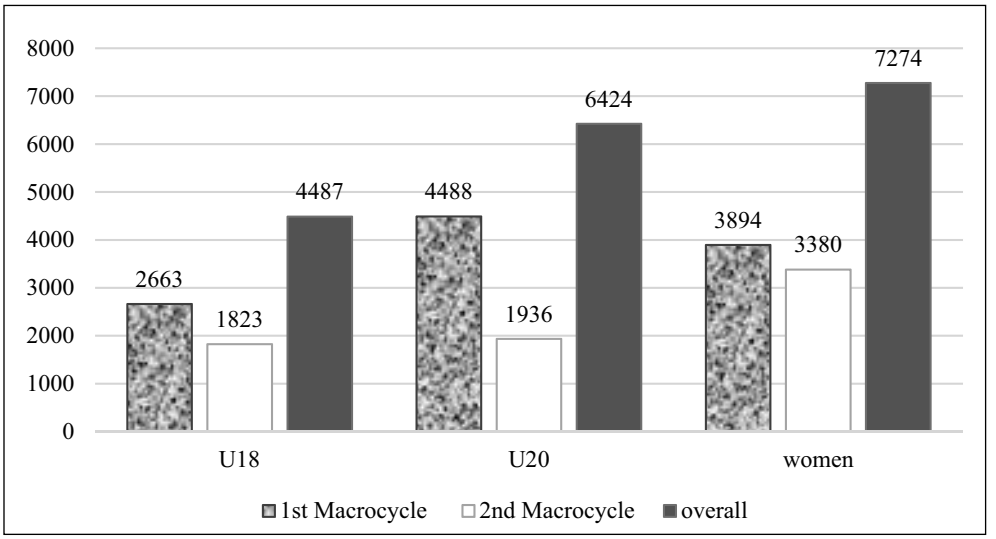

Figure 3. *Average volume of horizontal and vertical jumps (number of repetitions)*

DISCUSSION

The dynamic development of track and field preparation has to constantly update, change and improve. The study of preparation variations, that are known to be successful and efficient brings valuable theoretical information that can be used in the future. Systematization of data from the practice and indication of the basic volumetric parameters of training means for strength training in the 400 m run, will help for more purposeful preparation.

The study presents actual and specific information for different age groups for each group of exercise.

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REFERENCES

Bŭchvarov, M. And Antonov, N. (1991). *Sprint – trenirovka i upravlenie*.-NSA – IPB, Sofia. // Бъчваров, М., Н. Антонов, (1991). *Спринт – тренировка и управление*. НСА – ИПБ. София.

Bulgarian athletic federation. (2022). Systezatelni pravila IAAF 2019 - 2022 g. Available at https://www.bfla.org/, (accessed July 25, 2022).

Bulgarian athletic federation. (2022). Systezatelni pravila IAAF 2018 - 2019 g. Available at https://www.bfla.org/, (accessed July 25, 2022).

Dimitrov, D. (1987). Sportnata podgotovka v distsiplinata 400 m gladko byagane, Nastavlenie, ETSNPKFKS, Sofia. // Димитров, Д. (1987), *Спортната подготовка в дисциплината 400 м гладко бягане, Наставление*. ЕЦНПКФКС, София

Dimitrov, D. (2003). *Usŭvŭrshenstvane strukturata i sŭdŭrzhanieto na trenirovŭchniya protses v sprintovite byaganiya*. LTU, Sofia. // Димитров, Д. (2003). *Усъвършенстване структурата и съдържанието на тренировъчния процес в спринтовите бягания*, ЛТУ, София.

Dimitrov. D., Stoqnova, V., Aladjov, K. (1986). *Edinna programa po leka atletika za obuchenie i trenirovka v shkolite za masov sport i sportnite sektsi*. ETSNPKFKS. Sofa. // Динитров, Д., В. Стоянова, К. Аладожов. (1986). *Единна програма по лека атлетика за обучение и тренировка в школите за масов спорт и спортните секции*. ЕЦНПКФКС, София.

Gadev, M. (1996) Analiz na dinamikata na razvitieto na kompleksnite faktori na sportnoto postizhenie v sprinta za mŭzhe, *Sport i nauka br. 5*, Tip-top pres, Sofia // Гъдев, М. (1996). Анализ на динамиката на развитието на комплексните фактори на спортното постижение в спринта за мъже. *Сп. Спорт и Наука, бр. 5*, Тип-топ Прес, София.

Gutev, Gr. (2013). Zavisimosti i dinamika mezhdu rezultatite v otdelnite distsiplini i kraĭnoto postizhenie v chetiriboya za momicheta pod 14 god. *Sbornik dokladi ot Mezhdunarodna nauchna konferentsiya „Evropeĭski standarti v sportnoto obrazovanie*“, Vratsa. // Гутев, Гр. (2013). Зависимости и динамика между резултатите в отделните дисциплини и крайното постижение в четирибоя за момичета под 14 г. *Сборник доклади от Международна научна конференция „Европейски стандарти в спортното образование*“, Враца.

Gutev, Gr., Njagin, P. (2012). Research on the Bulgarian U14 track and field status and tendency of development. *Book of abstracts International Scientific Conference "Effects of Physical Activity Application to Anthropological Status of Children,Youth and Adults"*, Faculty of Sport and Physical Education, Belgrade, Serbia 11-12 December ISSN978-86-82055-92-7;2,6, pp 183.

IAAF. (2022). IAAF official web page. https://www.iaaf.org/ (accessed August 10, 2022).

Krŭstev Ĭ., Antonov, N. Et.al. (1985). *Edinna programa sprintovi i prepyat·stveni byaganiya,* BSFS, Sofia, 1985. // Кръстев, И., Н. Антонов, и кол. (1985). *Единна програма спринт и препятствени бягания. БСФС*, София, 1985.

Miguel, P. and Manuel, V. (2004). Speed strength endurance and 400m performance. *NSA by IAAF 19:4*, pp. 39-45.

Nyagin, Pl., Gutev, Gr. et. al. (2013) Technical and tactical characteristics of the 400 m hurdle running, *16th Scientific Conference FIS Communications 2013 in physical education, sport and recreation, and 1st International Scientific Conference 18th-19th of October 2013, Nis, Serbia, Book of Proceedings*, Nis, Serbia, ISBN 978-86-87249-53-0, pp. 89-93.

Slavchev A. (1999) Takticheskite varianti za razpredelenie na usiliyata po razstoyanieto ot mŭzhete i zhenite pri gladkoto byagane na 400 metra. *sp. Sport i nauka, br. 1a*, София. // Славчев, А. (1999). Тактически варианти за разпределение на усилията по разстоянието от мъжете и жените при гладкото бягане на 400 метра. *Сп. Спорт и наука, бр. 1А*, София.

Vittori, C. (2006). The development and training of young 400 meters runners. *New Studies in Athletics6:1*; pp. 35-64

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EFFECTS OF ROWING TRAINING PROTOCOLS ON SINGLE-HANDED DINGHY SAILORS

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ABSTRACT
The purpose of this study was to examine the effects of rowing training protocols on general physical preparation of single-handed dinghy sailors from Bulgaria. The sample of this study consisted of twenty-four Bulgarian sailors who participated in the 2021 Bulgarian National Sailing Championships. There are 10 Laser sailors, 6 Laser Radial sailors, and 8 Finn sailors aged 21.5±3. During the preparation period, all the athletes performed 5 sessions weekly, each session (50-60 min) and one short burst session for 8 weeks of functional training with a focus on general physical preparation - training on general endurance. The overall physical fitness was evaluated with a test battery including Anthropometry, Flexibility test (sit-and-reach), Power test (vertical jump), Strength tests (back squat and bench press), Strength endurance test (pull-up), Anaerobic capacity (40-second sprint test) and Aerobic capacity (4000 m test). It should be noted that all competitors improved their results in all the tests. The results showed that using Indoor Rowing Ergometer for functional training for eight weeks has a positive influence on general endurance for single-handed dinghy sailors. Compared with the pre-test, significant improvements were observed in the post-test in anaerobic capacity (40-second sprint test), aerobic capacity (4000 m test), and 4 min test, with $p < 0.05$ performances in all studied sailors. This fact proved that the use of an Indoor Rowing Ergometer is suitable for increasing the level of athletes' functional abilities.

Keywords: *Sailing, training, Finn, Laser, preparation, Indoor Rowing*

INTRODUCTION

Modern sports pose extremely high requirements for both the practitioners and the entire coaching staff. Sailing, in particular, requires athletes to be in top physical condition and to possess well-learned motor skills due to the intermittent, dynamic nature of the sport. From a physiological point of view, Felici et al. (1999) described dinghy sailing as a sport characterized by a relatively low energy requirement but with a high cardiovascular demand.

The physiological demands vary according to the sailing class but elements of each are present across the range. The single-handle dinghies are the most physically demanding of the Olympic classes. Prior to 1994, single-handed sailing was considered relatively static; where the main physiological task was thought to be the isometric contractions in the lower body and abdominal muscles during the hiking position. Hiking has been described as a bilateral and multi-joint movement which generates fatigue, or quasi-isometric stress, in the anterior leg muscles that cross the knee and hip joint (Spurway, 2007; Sekulic et al, 2006; Maïsetti, et al., 2006; Vogiatzis, et al, 1995). Further research on sailing has challenged this view by suggesting that sailing provides greater physiological demands than initially thought (Cunningham & Hale, 2007), with an increase in the importance of muscular strength, muscle endurance, and aerobic and anaerobic capacity (Bojsen-Møller et al., 2015).

The different techniques in the various single-handed sailing classes require different physiological demands and thus, training and program design need to be centered on the individual sailors and their boat specifics (Bojsen-Møller et al. 2007). Furthermore, it is important to note that the load is changing during different legs of the course, i.e. upwind and downwind (Draper & Hodgson, 2008). Upwind sailing is the stage with the highest physical demands on sailors, the side-deck hikers will use hiking technique 94% of the time in winds more than 8 knots which clearly increases the physiological demands (Legg et al. 1997). As we know, the single-handed dinghy sailors greatest exerted physical maneuver is a hiking, which needs strong strength and endurance of quadriceps as well as abdominal muscles. (El Beih, 2021).

Taking into account the intensity and duration of work during competitions, we can talk about the need for a very high level of functional readiness of athletes. Among the group of the youth, where the difference in physical fitness is still not so important and noticeable, Bulgarian sailors perform well at both World and European championships.

But in seniors (men's) groups, our athletes are significantly behind world leaders in this regard. The insufficient level of functional training makes it difficult for them to master the necessary technical elements (Geshev, 2014).

The lack of more extensive knowledge in the field of training for general and specific preparation on land, workload, and recovery raises many questions for our coaches about the proper preparation of single-handed sailors and the optimization of their training process. Nowadays coaches look for different means of training which can effectively improve the physical preparation of qualified athletes. Using a rowing machine is one of these methods. Sailors from many countries use Indoor Rowing Ergometers to test fitness and to develop the power, strength, and aerobic fitness needed to meet the physiological demands of competitive sailing (Fletcher, 2008). In this way, they get used to working hard and try to replicate racing conditions on land in the form of interval/ lactate training.

The purpose of this study was to examine the effects of rowing training protocols on the general physical preparation of single-handed dinghy sailors from Bulgaria in their general physical preparedness period. In order to fulfill the aim of the research we set the following tasks:

- Research of the available literature on the topic.
- Selection of three tests to determine the level of functional abilities of athletes
- Testing and collecting the results.
- Analysis of the obtained results.
- Formulation of conclusions and recommendations based on the obtained results.

In order to fulfill the aim of the research we surveyed the available literature and, on this basis, selected eight tests to determine the level of functional abilities of athletes. The tests are easily applicable in practice and informative enough.

METHODS

Sample and study design

The sample of this study consisted of twenty-four Bulgarian sailors who participated in the 2021 Bulgarian National Sailing Championships. There are 10 Laser sailors, 6 Laser Radial sailors, and 8 Finn sailors aged 21.5±3. All sailors underwent a systematic medical examination to exclude patients with major diseases. The content, process, and potential risks of the study were explained to all the participants, who voluntarily joined this study with informed consent. The study protocol was conducted in agreement with the principles stated in the Declaration of Helsinki for human studies (WMJ, 2008) and in compliance with the ethical code of the National Sports Academy (2019).

Preliminary testing was conducted on the first three days of the study at the beginning of the preparation period. The final testing was organized 2 days after the last training session in the program. On the first day, anthropometric measurements, no fatiguing tests (height, weight, sit-and-reach, vertical jump), and anaerobic capacity test (40-s sprint rowing test) were assessed. On the second day, muscular strength (back squat, bench press) and strength endurance tests (pull-ups) were performed. On the last day, aerobic capacity was tested (4 km rowing).

Based on the results of the preliminary test, the level of all competitors were determined on Level 5 (Fletcher, 2008). To develop their physical abilities for a period of eight weeks, all the sailors performed 5 sessions weekly, each session (50-60 min) and one short burst session based on the Indoor Rowing Sailing Guide by Eddie Fletcher.

Anthropometry

The measurements were Height (cm), weight (kg), BMI (kg/m2), and the test tools were a height meter and weight scale. The tests were completed in strict accordance with the detailed rules of "Sports Measurement and Evaluation".

Flexibility test (sit-and-reach)

The sailors places one hand on top of the other, slowly bends forward, and reaches along the top of the ruler as far as possible, holding the stretch for two seconds. The assistant records the distance reached by the athlete's fingertips (cm). The best of three trials were recorded.

Power test (vertical jump)

The sailors stand side on to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach. The person puts chalk on their fingertips to

mark the wall at the height of their jump. The person then stands away from the wall and jumps vertically as high as possible using both arms and legs to assist in projecting the body upwards. Attempt to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height is the score. The best of three attempts is recorded.

Anaerobic capacity (40-s sprint rowing test)

The sailors' anaerobic capacity (peak and mean power output) was performed on a rowing ergometer (Concept 2 Indoor Rower). Before the test, the athletes performed routine warm-ups and carried out 1 incremental load rowing and 2 short sprints (5-s maximal sprints with 20-s of easy rowing between) on the rowing machine. The test was conducted after a 60-s rest. All subjects were instructed to perform the sprint as a maximal all-out effort with a drag factor relative to their individual body weight, the computer attached to the rowing ergometer was used to record 40-s mean and peak power output during the sprint test.

Strength tests (back squat and bench press)

Familiarization was conducted through a self-determined, exercise-specific warm-up typically consisting of 3-4 sets of the particular exercise with submaximal loads, beginning with a relatively light one. The first warmed up using 50% of the athlete's estimated 1RM weight. After resting 1-5 min, the strength and conditioning professional increases the weight by 5-10% in the bench press and 10-20% in the back squat. The 1RM was determined within six attempts.

Strength endurance test (pull-up)

The sailors hold the bar with their forehands and arms outstretched as the starting position and then pulled their bodies up until lower jaw was above the horizontal bar. Returning is to the fully extended suspension position on each repeat. The sailors can't make any unnecessary movements, including excessive body sway. (Coyne, 2015)

Aerobic capacity (4 km rowing)

Rowing at maximum capabilities on a distance of 4000 meters on a rowing ergometer "Concept II", Model D, with a drag factor set at 130, each sailor's time was recorded.

Statistical analyses

Collected survey data were statistically processed with the specialized program SPSS version 19.0. Descriptive statistics were used to characterize the distribution of data after applying the tests. Student's paired t-test was applied to find the differences in results between the two tests – at the beginning and at the end of our study. The level of significance of $p \leq .05$ was adopted in all cases. For each test, according to the results of the observation, the mean and standard deviation was obtained to control the overall level of development of each of the groups.

RESULTS

Table 1 is the demographic information of all sailors. Radial (ILCA 6) sailors were shorter, lighter, and had a lower BMI than other sailors. The height of Finn was similar to Laser (ILCA 7) sailors, but the weight and BMI were significantly higher ($p < .01$). Finn sailors were significantly higher than ILCA 6 sailors ($p < .01$).

Table 1. *Demographic information of all sailors.*

	ILCA7 (n=10)	ILCA6 (n=6)	FINN (n=8)
	mean ± SD	mean ± SD	mean ± SD
Age (years)	21.39 ± 4.8	20.36 ± 3.28	21.44 ± 2.34
Sailing experience (years)	6.79 ± 4.68	6.52 ± 5.49	7.22 ± 3.55
Height (cm)	182.08 ± 5.04	171.43 ± 3.62	186.62 ± 6.36*
Weight (kg)	76.26 ± 4.69	60.82 ± 4.29	88.36 ± 6.14**
BMI kg/m^2	23.01 ± 1.34	20.7 ± 1.33	24.13 ± 1.52*

*Note: *significant difference compared with the ILCA 6 sailors ($p < .05$), **significant difference compared with the ILCA 6 sailors ($p < .01$).*

Table 2. *The results of the physical fitness tests in all sailors.*

Indicator/Group		Beginning	End	Difference		Statistical significance	
		mean ± SD	mean ± SD	d	d%	t	P(t)
Bench press (kg)	ILCA7	81.23 ± 5.06	85.45±6.72	4.22	5.20%	1.59	0.130
	ILCA6	70.54 ± 4.83	74.34 ± 5.11	3.80	5.39%	1.32	0.215
	FINN	89.30 ± 8.53	93.57 ± 7.28	4.27	4.78%	1.08	0.300
Back squat (kg)	ILCA7	83.36 ± 7.31	88.53 ± 6.52	5.17	6.13%	1.67	0.112
	ILCA6	73.12 ± 6.22	77.25 ± 5.45	4.13	5.65%	1.22	0.249
	FINN	93.39 ± 5.74	99.13 ± 4.33	5.74	6.16%	2.26	0.040
Vertical jump (cm)	ILCA7	50.17 ± 5.21	53.20 ± 5.64	3.03	6.04%	1.25	0.228
	ILCA6	50.66 ± 5.44	53. 31 ± 4.89	2.65	5.23%	0.01	0.991
	FINN	48.06 ± 4.87	51.12 ± 5.22	3.06	6.37%	1.12	0.245
Sit-and-reach (cm)	ILCA7	24.36 ± 5.24	25.03 ± 6.32	0.67	2.75%	0.00	0.997
	ILCA6	25.72 ± 6.52	26.07 ± 6.14	0.35	1.36%	0.10	0.926
	FINN	22.05 ± 5.25	22.07 ± 6.25	0.02	0.09%	0.00	0.995
Pull-up (reps)	ILCA7	20.31 ± 4.49	21.55 ± 4.72	1.24	6.10%	0.6	0.555
	ILCA6	18.24 ± 3.55	19.05 ± 5.19	0.81	4.44%	0.32	0.759
	FINN	17.06 ± 5.42	18.16 ± 4.56	1.10	6.45%	0.44	0.667
Rowing peak power (W)	ILCA7	628.33±26.12	688.64±23.31	60.31	9.59%	5.45	0.000
	ILCA6	539.25±12.50	593.43±21.45	54.18	10.05%	5.35	0.000
	FINN	742.75±20.61	794.75±11.53	52.00	7,00%	6.23	0.000
Test 4 min. (m)	ILCA7	1012.22±32.12	1074.62±24.22	62.40	6.16%	4.91	0.000
	ILCA6	983.76±26,42	1031.36±25,74	47.60	4.84%	3.16	0.010
	FINN	1182.25±21.14	1221.00±13.34	38,75	3,28%	4.38	0.001
Test 4000m (s)	ILCA7	898.54± 18.82	879.31±8.13	19.23	2.14%	2.97	0.008
	ILCA6	906.23± 19.44	883.66±9.32	20.57	2.06%	2.56	0.028
	FINN	892.75± 16.58	874.75±7.37	18.00	2.02%	3.26	0.014

Table 2 shows the results of the physical fitness tests for all sailors. Compared with the pre-test, significant improvements were observed in the post-test in anaerobic capacity (40-second sprint test), aerobic capacity (4000 m test), and 4 min. test, with $p < .05$ performances in all studied sailors. The back squat strength of Finn sailors was significantly improved ($p < .05$).

DISCUSSION

The aim of this study was to examine the effects of rowing training protocols on the general physical preparation of single-handed dinghy sailors from Bulgaria in their general physical preparedness period, findings of the study were presented for all tests before and after the applied functional training program. To assess the level of physical fitness of the tested subjects we used eight special tests. It is noted that all competitor improved their results in all tests, which is not surprising, given that the entrance tests were made at the beginning of the general preparation period and the output - at the beginning of the special preparation period.

Data showed as presented in Table 2, a positive significant difference in anaerobic capacity (40-second sprint test), aerobic capacity (4000 m test), and 4 min. test, with $p < .05$. These positive differences reflect sailors' adaptation to the applied functional training program, which supports the main aim of the study.

Anaerobic capacity is an important parameter for athletic performance, not only for short high-intensity activities but also for breakaway efforts and end spurts during endurance events (Noordhof et

al., 2013). Our study examines the aspect of anaerobic capacity and of lower-body power using the 40-second sprint test. The peak power out recorded is the maximal power output achieved for the test. We examined other similar studies that used Concept 2 for the evaluation of the physical readiness of single-handed sailors. The values of maximum power received by Fletcher (2008) were 803-860W (Finn), and 703-727W (Laser), which is above the values that were obtained in our study. Kistanov (2016) registered the maximum power of 8 experienced participants. The results varied from 492W to 590W, and the average was around 542.25 W for Finn sailors and 423-505W with an average of around 435,75W for Laser sailors. Skrypchenko (2017) studied elite sailors in order to estimate the maximum speed power. The average maximum power measured was 839.5 W for Finn sailors.

Previous studies found that aerobic demand is significantly more important for single-handed sailors and blood lactate concentrations never reach a very high level even at the end of hard hiking. (Cunningham & Hale, 2007; Vogiatzis, et al, 1995). We cannot ignore that the oxygen intake of the sailors during sailing is kept at a low level, aerobic capacity is only used moderately and should not be overemphasized in training. (Vogiatzis et al. 1995, Vito et al. 1996). In the strong wind anaerobic capacity plays a more and more important role, especially in hiking, the motion of lower body quasi-isometric contraction to produce certain blood restriction, quadriceps' muscle oxygen saturation decreases obviously, so in the process of single-handed dinghy sailing requirements high-level anaerobic capacity (Vogiatzis et al. 1995, 2008). Vangelakoudi et al. (2007) suggest that mean and maximal anaerobic power and ranking of the nationally ranked sailors have strong correlations. When sailors suddenly pull the sheet, to contract to a significantly higher number of muscle cells than in the conditions of daily life, will be use a certain amount of energy from their anaerobic capacity (Lozovina, Đukic, 2017).

In addition to the fact that the competitors from our study showed a stable qualitative increase of the results in all of the tests, the coaches of the National Team noticed that the competitors began to perform the technical elements more consistently – faster, with fewer mistakes. The power of water, such as "pumping", has increased in a group of Finn sailors. Athletes have become more resilient, they have improved both their control over their own body and their self-esteem.

A limitation of this study is the relatively small sample size; however. the sample consisted of national and international level sailors and the recruitment of such participants can be difficult. However, the sample size recruited in this study is comparable to previous investigations of similar groups (Kistanov, 2016; Skrypchenko, 2017). Notwithstanding, however, larger sample sizes are needed to ensure statistical validity, and therein represents a relevant path for further work.

CONCLUSION

The significant difference in anaerobic capacity (40-second sprint test), aerobic capacity (4000 m test), and 4 min. test, with $p < .05$., proved that the use of an Indoor Rowing Ergometer for 8 weeks is suitable for increasing the level of athletes' functional abilities. At the same time, it should not be forgotten that such training is effective only if the load corresponds to the level of preparation of the competitors. During the preparation period, a careful medical monitoring and constant feedback between the coach and the athlete are required to prevent overtraining and injury. It is recommended that we use the proposed method only with well-trained. experienced athletes. The trainer is also advised to conduct 2-3 full workouts for flexibility and relaxation per week. as well as to change the training means to avoid fatigue and routine in the actions.

For a better effect, we recommend actual sailing in addition to land-based training. While the physiological adaptations to sailing are probably a little more modest we can gain a huge amount of technical advantages. Learning to shift tension on and off the muscle can help prolong endurance. Holding more efficient energy-saving postures can also buy us time in relation to fatigue. Our tolerance for hiking is also improved. The more we train and become accustomed to certain processes. the better we cope. Inhibitory sensors within the muscle can be somewhat overridden with training. In short, hiking more allows us to manage the fatigue more effectively.

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REFERENCES

Bojsen-Møller. J., Larsson. B., Magnusson. S. P. & Aagaard. P.(2007). Yacht type and crew-specific differences in anthropometric. aerobic capacity. and muscle strength parameters among international Olympic class sailors. *Journal of Sports Sciences.* 25. 1117–1128. https://doi.org/10.1080/02640410701287115.

Bojsen-Møller. J., Larsson. B., & Aagaard. P. (2015). Physical requirements in Olympic sailing. *European Journal of Sport Science. 15*(3). 220–227.

https://doi.org/10.1080/17461391.2014.955130.

Code of ethics – National sports academy "Vasil Levski". (2019). Sofia. // Етичен кодекс на НСА „Васил Левски". (2019). София.

Coyne, J. O., Tran, T. T., Secomb, J. L., Lundgren, L., Farley, O. R., Newton, R. U., & Sheppard, J. M. (2015). Reliability of pull up & dip maximal strength tests. *J Aust Strength Cond*, 23, 21-27.

Cunningham, P., & Hale. T. (2007). Physiological responses of elite Laser sailors to 30 minutes of simulated upwind sailing. *Journal of Sports Sciences.* 25(10). 1109–1116. https://doi.org/10.1080/02640410601165668.

Draper, N., & Hodgson, C. (2008). *Adventure sport physiology*. John Wiley & Sons. NJ

El Beih, S. H., & Fakhry, A. E. (2021). Effect of functional core conditioning training on hiking at sailing radial. *International Journal of Sports Science and Arts*, *17*(017), 91-110.

https://doi.org/10.21608/EIJSSA.2020.51218.1058

Felici, F., Rodio, A., Madaffari, A., Ercolani, L., & Marchetti, M. (1999). The cardiovascular work of competitive dinghy sailing. *Journal of Sports Medicine and Physical Fitness*, 39(4), 309.

Fletcher, E., & Cunningham, P. (2008). *Indoor Rowing Sailing Guide*.

https://www.yumpu.com/en/document/view/3809470/concept2-sailing-rowing-guideindd-fletcher-sport-science

Geshev, P. (2014). *Vetrohodstvo*. NSA PRES. Sofia. // Гешев, П. (2014). Ветроходство. НСА ПРЕС. София.

Kistanov, A. (2016) Increasing of functional ability of high qualified saiors. *Proceedings Of X International Scientific and Practical Conference of Students and Young Scientists „Modern University Sport Science"* p. 60-63

Legg, S. J., Miller, A. B., Slyfield, D., Smith, P., Gilberd, C., Wilcox, H., & Tate, C. (1997). Physical performance of elite New Zealand Olympic class sailors. *The Journal of sports medicine and physical fitness,* 37(1), 41–49. PMID: 9190124

Lozovina, M., & Đukić, N. (2017). Anthropometric-morphologic, psychomotor, energetic and technicaltactic features of sailors in olympic classes. *Sport Sci*, 10(1), 7-18.

Maisetti, O., Boyas, S., & Guével, A. (2006). Specific neuromuscular responses of high skilled laser sailors during a multi-joint posture sustained until exhaustion. *International journal of sports medicine*, 27(12), 968-975.

Noordhof, D. A., Skiba, P. F., & de Koning, J. J. (2013). Determining anaerobic capacity in sporting activities. *International Journal of Sports Physiology & Performance*, 8(5).

Sekulic, D., Medved, V., & Rausavljevi, N. (2006). EMG analysis of muscle load during simulation of characteristic postures in dinghy sailing. *Journal of sports medicine and physical fitness*, *46*(1), 20.

Skrypchenko, I. T. (2017). Indoor rowing for sportsmen in sailing. *ББК 75.4 (0) 90к. я431 В 78 Молодь та олімпійський рух: Збірник тез доповідей X Міжнародної наукової конференції, 24-25 травня 2017 року [Електронний ресурс].–К., 2017.*, *7*, 170.

Vangelakoudi, A., Vogiatzis, I., & Geladas, N. (2007). Anaerobic capacity, isometric endurance, and Laser sailing performance. *Journal of sports sciences*, *25*(10), 1095-1100.

Verdon, A., Lee, H., & Blackburn, M. (2012). Sailing. In *Physiological tests for elite athletes* A. N. Tocco (Ed.) (pp. 411–419). Champaign: Human Kinetics.

De Vito, G., Di Filippo, L., Felici, F., Gallozzi, C., Madaffari, A., Marino, S., & Rodio, A. (1996). Assessment of energetic cost in Laser and mistral sailors. *International Journal of sports cardiology*, *5*(2), 55-59.

Vogiatzis, I., Spurway, N. C., Wilson, J., & Boreham, C. (1995). Assessment of aerobic and anaerobic demands of dinghy sailing at different wind velocities. *The Journal of sports medicine and physical fitness*, *35*(2), 103-107.

Vogiatzis, I., Tzineris, D., Athanasopoulos, D., Georgiadou, O., & Geladas, N. (2008). Quadriceps oxygenation during isometric exercise in sailing. *International journal of sports medicine,* 29(01), 11-15. https://doi.org/10.1055/s-2007-964993.

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METHODOLOGY FOR ONLINE BEGINNERS' GYMNASTICS TRAINING

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ABSTRACT
The pandemic set a huge challenge to the work of coaches, as the circumstances required to have trainings at home and in an online learning environment for which there were no ready and custom-made materials. This led to our study, which is focused on structuring a methodology for online rhythmic gymnastics training for beginners.
The study developed in two stages: during the first stage we created a questionnaire, we organized and filmed the new methodology with a total of 48 exercises, conducted an initial stage of testing a control and an experimental group, trained the parents of our participants to use the ZOOM platform; the online trainings were held for 3 months. The experimental group was trained in accordance with the methodology proposed, following a certain algorithm. The exercises of the methodology were demonstrated to the children with photos and videos, and the demonstrators were dressed and made up with costumes of famous characters from various fairy tales or children's entertainment shows. The control group was trained using the methodology of their lead coach, in which the exercises were included in combinations, without prior study, and did not follow a specific training algorithm. After that experiment, during the second stage of the study, a final testing was made to evaluate the results, run a statistical processing, analyze the results and complete the project.
The results from the analyses show that the methodology used in this algorithm and with the proposed photos and videos is well mastered by the beginner gymnasts. The difference in growth in both groups in the initial testing is minimal. In the final testing, the increase between the average values of the two groups increased significantly in favour of the increased maximum results in the experimental group. During the experiment, no children lost their interest in the conducted training as observed in the control group.

Keywords: *rhythmic gymnastics, beginners, online and distance education*

INTRODUCTION

Many eager and young coaches simply skip the ABC's in training their gymnasts and directly give more complex exercises and combinations and wonder later why they failed to achieve the desired results or why the class of the best seems out of reach. The biggest mistake in gymnasts training nowadays is the impatience to properly lay the foundation, learn the basic exercises correctly, and then move on to mastering complex and difficult movements and combinations (Gateva, 2020). The effective methods used by leading specialists are not always known to all coaches and they need methodical help to rely on during training. Enhancing traditional training by using knowledge about the kinematic and dynamic parameters of exercises can optimize the technical training of gymnasts (Gancheva, 2008)

The COVID-19 pandemic has put the world of sports to serious tests. The usual way of life of people involved in sports – athletes, coaches, sports technical staff, and managers – is undergoing a serious change. From a lifestyle full of physical activity, numerous trips, competitions, self-expression, and pursuit of success, and strong emotions caused by sports competitions, they had to adapt to a lifestyle in an environment of confinement. At first, they were prevented from their usual activities, and then they had to engage in activities with unclear prospects and fear of illness. In such an unusual environment full of tension and vagueness, the need to adapt and actively deal with and forecast sports and competitive activities in the conditions of COVID-19 becomes much more important (Iancheva, 2020). The spread of COVID-19 and the growing global pandemic required rapid adaptation and a completely new approach to teaching and handling with the learning process in a number of disciplines. The specificity of each subject and its online teaching requires a certain modification of the content, topics, duration, and a number of other factors (Dimitrova, 2020).

Teaching of rhythmic gymnastics, as well as other types of gymnastics, must be constantly pursued in compliance with the prerequisites of the field of pedagogy and sports sciences, in the perspective of continuous improvement (De Toledo, 2020).

Coaches' continuous creative searches and the invention of new exercises, connections, and combinations enriches the discipline, but meanwhile, a need for new teaching and training methods arises (Gancheva, Zareva, Ivanova, 2015).

Such a methodology is the Sports and Technical Levels in Rhythmic Gymnastics (Bulgarian Rhythmic Gymnastics Federation (BRGF), 2020), which is a system for evaluating the training of gymnasts. The levels are 10 in total and cover four components of training: technical (with body and apparatus), physical, dance and musical-creative level. Each level contains 10 main groups of exercises arranged in a certain algorithm.

The pandemic has turned the work of coaches into a huge challenge, as the circumstances forced home training and online learning environments. Especially for beginner gymnasts who have no number of exercises learned, this became a very difficult task The purpose of the study is to structure a methodology for online training in rhythmic gymnastics for beginners.

The set tasks are:

- To examine literary sources on the matter.
- To actively study the problems of distance learning in rhythmic gymnastics.
- To test the methodology proposed in reality.

METHODS

Object of the study is the online distance learning of beginner gymnasts, 4-6 years old.

Subject of the study – 10 exercises for technical training without apparatus.

Participants in the study – 40 beginner girls aged 4-6 years. The girls are divided into two groups – a control group and an experimental group. An experimental group of 20 gymnasts from the TEA DANCE Rythmic Gymnastics Sports Club of the town of Elin Pelin and a control group of 20 gymnasts from the TEA SPORT 2018 Rythmic Gymnastics Sports Club of the village of Gorna Malina. Both groups have been training for no more than three months in rhythmic gymnastics according to the methodology used by their coaches. During two of these three months, the children were trained remotely. All participants in the inclusion in the practice provided informed consent from their parents for participation in the study and filming.

Objective of the questionnaire – the opinion of practicing coaches from Bulgaria and abroad about distance online training in rhythmic gymnastics.

Participants in the survey - 64 interviewed coaches.

Methodology and methods of the study

This study was conducted in two stages. During the first stage, we created a questionnaire, organized and filmed the new methodology with a total of 48 exercises, conducted an initial stage of testing a control and an experimental group, trained the participants' parents on using the ZOOM platform, and conducted online training for 3 months. Trainings were conducted 3 times a week for 60 minutes in observance of the usual structure of the training (preparatory part, main part, and final part). The experimental group was trained according to the methodology proposed, following a certain algorithm. Exercises of the methodology were demonstrated to the children with photos and video materials through the Share screen option in ZOOM. The control group was trained under the methodology of their leading coach, in which the exercises were included in combinations, without prior breakdown or preparatory study, and by following no specific training algorithm. After the experiment, during the second stage of the study, a final testing was carried out to determine the results of the new distance learning methodology; then, we processed statistically and analyzed the results, and completed the project.

The methods used were: questionnaire, pedagogical experiment, pedagogical monitoring, creating an evaluation table for expert evaluation, determining test exercises for technical training and evaluation criteria, video recording of the methodology, statistical reasoning, and comparative analysis of the testing results of the experimental and the control group, before and after testing the methodology using mathematical-statistical methods (variation analysis, Student's t-test).

For evaluating the technical preparation, 10 exercises with the body from the system for the Golden Rose Sports and Technical Levels– Level 1

were used. Each level contains the following main groups of exercises: steps; waves; balances; rotations; jumps; acrobatic exercises; physical fitness tests; technique with an apparatus, and a musical and creative task (BRGF, 2020).

RESULTS

Analysis of the questionnaire results

57 out of 64 respondents completed the questionnaire. The questionnaire included 20 questions aimed at determining the extent to which online training is applicable in rhythmic gymnastics. Figure 1 and Figure 2 show two questions from the questionnaire.

The result of question 13 (Figure 1) shows that the largest percentage of those who had difficulty in teaching exercises online is when working with preparatory groups (64.9%), followed by mass sports groups (15.8%). This gives us a reason to focus the online methodology mainly on this pool of participants since these children have spent the least time in the gym, and most certainly, learning new material online is more difficult for them than for the competitors with more experience.

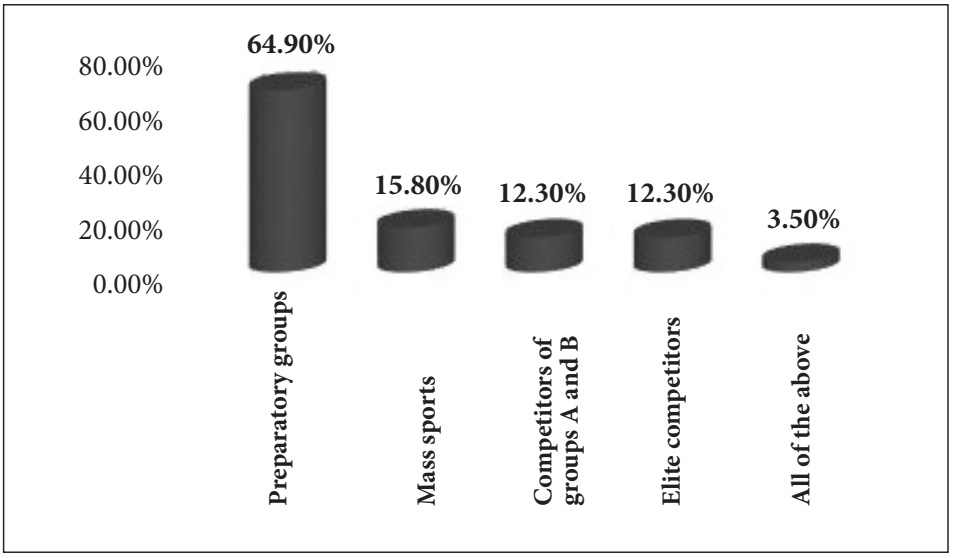

Figure 1. *Which groups faced the greatest difficulty in teaching the exercises online*

According to the data from question 18 (Figure 2), 73.7% of our coaches participating in the study believe that there is a need for more ready-made online materials to facilitate their work, and 26.3% do not think that there is a need of such materials.

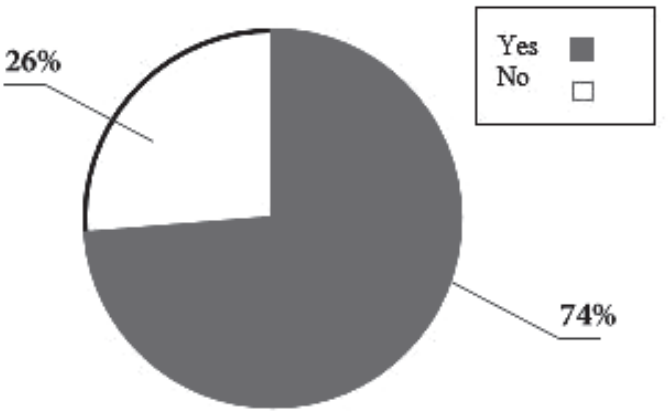

Figure 2. *Are there enough ready-made materials for online training (Question 18)*

Analysis of the study results

After examining and analyzing statistically the data separately for each study from the values measured and the results obtained, we found that the results of the experimental group have improved significantly; this can be seen from the average values obtained in our studies.

We present the results of the comparative analysis between the experimental and the control group before and after implementing the methodology in exercise IV – gymnastic walking on the whole feet with hands on hips:

Table 1 shows close average values for the two groups during the initial testing – the minimum value for the experimental group was 1.67, and for the control group, it was 1.00, and the maximum values were 4.00 and 3.67, respectively (Figure 3). The variation coefficient (V) in the experimental group is 24.90, which shows that the group is approximately uniform and in the control group V is 44.54 showing that the group is highly heterogeneous. The distribution in both groups is symmetrical with normal kurtosis. Table 2 shows that the guaranteed probability of the study is 99.83%, which shows that the difference is statistically significant. The difference and weight increase in both groups are minimal.

Table 1. *Variance analysis of Exercise IV - walking on whole feet, hands on hips of experimental and control group, at initial testing*

Group	n	X min	X max	R	X	S	V	As	Ex
Experimental	20	1.67	4	2.33	2.93	0.73	24.9	-0.218	-0.972
Control	20	1	3.67	2.67	2.05	0.91	44.54	0.389	-0.945

Table 2. *Comparative analysis of the average values of experimental and control group in Exercise IV – walking on whole feet, hands on hips, before starting the experiment*

	Experimental			Control			Difference	Statistical significance	
Indicators	n1	`X1	S1	n2	`X2	S2	d	t emp	P (t)
Exercise IV	20	2.93	0.73	20	2.05	0.91	0.88	3.38	99.83

In the final testing on Table 3, we observe greatly increased scores in the experimental group and almost unchanged ones in the control group. The variation coefficient (V) in the experimental group shows that the group has become highly uniform and V in the control group is 33.01 and the group has remained highly heterogeneous. The difference between the values of the two groups becomes very large in favor of the experimental group (Figure 4). According to Table 4, for both the experimental group and the control group t_{emp} =2.09 > t (α = .000), i.e., the alternative hypothesis is accepted as true, which states that the difference (2.09) observed in the results is statistically significant and not accidental. The guaranteed probability of the study is 100%, indicating that the difference is statistically significant. The increase between the average values of the two groups increased significantly (2.58).

Table 3. *Variance analysis of Exercise IV – walking on whole feet, hands on hips of experimental and control group, at final testing*

Group	n	X min	X max	R	`X	S	V	As	Ex
Experimental	20	4.67	6	1.33	5.28	0.47	8.99	0.17	-1.384
Control	20	1	3.67	2.67	2.7	0.89	33.01	-0.523	-1.226

Table 4. *Comparative analysis of the mean values of the experimental and control group in Exercise IV – walking on whole feet, hands on hips, after setting the experiment/*

	Experimental			Control			Difference	Statistical significance	
Indicator	n1	`X1	S1	n2	`X2	S2	d	t emp	P (t)
Exercise IV	20	5.28	0.47	20	2.7	0.89	2.58	11.44	100

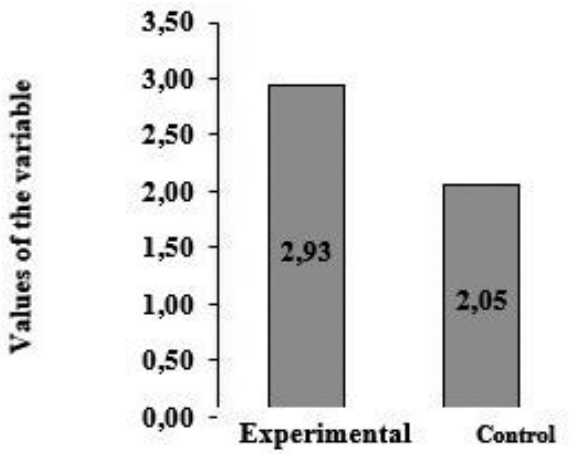

Figure 3. *Initial Testing Exercise IV*

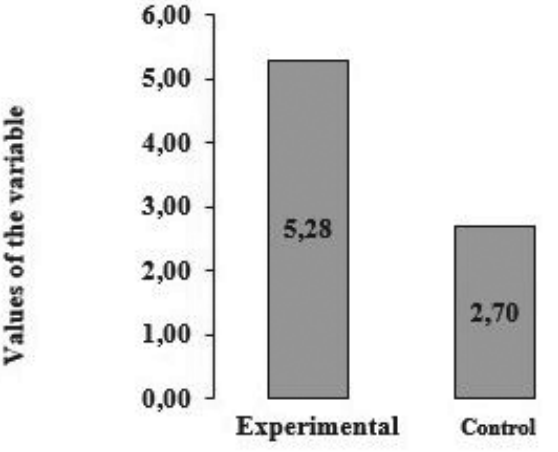

Figure 4. *Final Testing Exercise IV*

In summary, it can be concluded that the results of the experimental group increased compared to those of the control group. The difference in the increase in the scores of the two groups after the end of the experiment was significant, with a large improvement in the score of the experimental group. This is due to the algorithmic and systematic application of the methodology proposed.

DISCUSSION

The questionnaire revealed that online training for beginners was the most difficult for coaches to deal with (64.9%). According to the questionnaire, 73.7% of coaches believe that there is a need for materials suitable for online training in rhythmic gymnastics. Before the pandemic, 93% of the respondents never conducted online training, and with the onset of the pandemic, 91.2% of the coaches are already conducting such activities.

The methodology proposed (Figure 5 and Figure 6) is used entirely in distance learning in a direct online connection in the ZOOM Platform. The results of the analyses show that the use of this algorithm and the proposed photo material was well understood by the beginner gymnasts on whom it was applied. During the experiment, no children lost their interest in learning, opposite to what was observed in the control group.

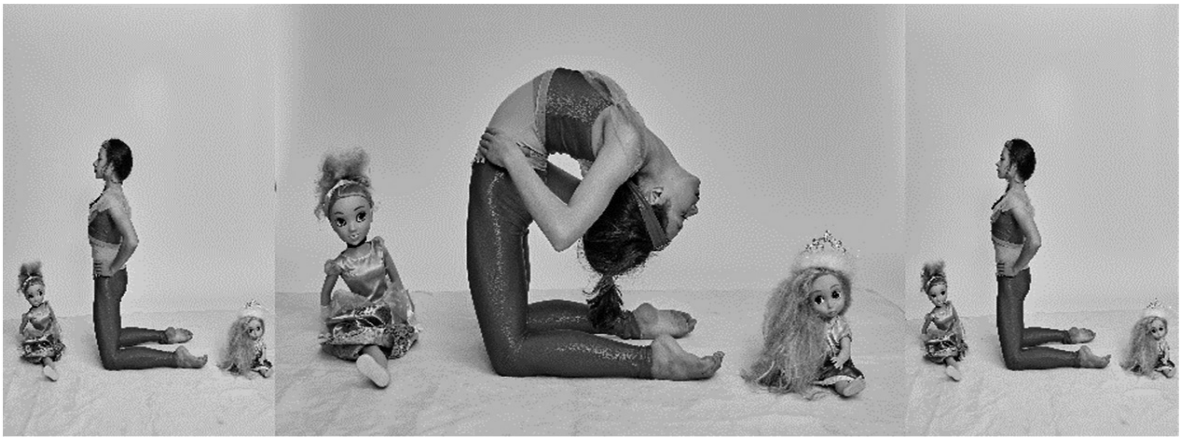

Figure 5. *Exercise 32. Online methodology for training beginners*

Figure 6. *Exercise 7. Online methodology for training beginners*

The analysis of the research results shows that the methodology applied is, in fact, effective. Before applying the methodology, the experimental group had a variation coefficient between 10-30%, and the group was approximately uniform with a minimum mean value of 2 and a maximum of 4. After applying the proposed methodology, the experimental group became highly uniform, lowering the percentage of variation to 10%, the minimum average values are above 4.50 and the maximums reach the maximum test score of 6.

CONCLUSION

During our study of literature sources on the matter at issue, we did not find any information about a similar online methodology for rhythmic gymnastics classes. On the basis of the results obtained, we recommend that the coaches who are interested in this matter get familiar with the proposed methodology for online training in rhythmic gymnastics for beginners. The experimental methodology can be used in other gymnastics disciplines, as well as in other types of extracurricular activities, both online and in standard settings.

REFERENCES

Gancheva, G., Mineva, M. (2008). Optimizirane obucheieto na shirokite skokove v hudozhestvenata gimnastika, *Sport i nauka* izv.br. 3, Sofia.

Gancheva, G., Zareva, I., Ivanova, V. (2015). Obogatyavane metodikata na obuchnie v hudozhestvenata gimnastika, *Sport I nauka,* br. 4, Sofia.

Gateva, M. (2020). *Tehnicheska podgotovka v hudozhestvenata gimnastika,* Chast 1, BULGED OOD.Sofia.

Dimitrova, R. (2020). *Fizicheskoto vazpitanie i sport v uslovia na pandemia*. Departament po sport, Universitetsko izdatelstvo "Sv. Kliment Ohridski", Sofia.

Iancheva, T. (2020). Hudozhestvenata gimnastika v usloviyata na pandemia ot Covid-19 – psihologicheski problem I pedagogicheski posledstviq, *Procceding Book Of The First International Online Conference & Seminar In Rhythmic Gymnastics*, NSA Press, Sofia.

E.de Toledo. (2020). Requirements for the teaching of rhythmic gymnastics: paulo freire perspectives, *Proceeding Book Of The First International Online Conference & Seminar In Rhythmic Gymnastics*, NSA Press, Sofia.

BHFG, Pravila za pokrivane na sportno-tehnicheski niva v hudozhestvenata gimnastika "Zlatna roza", Utvarden ot US na BFHG s Protokol №228. Reshenie №5 ot 19.06.2020 r.

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MODIFICATION OF THE METHODOLOGY FOR INITIAL TRAINING IN ALPINE SKIING TECHNIQUE

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ABSTRACT
The present work, based on a dialogue between the methodological experience of leading training systems in initial skiing training, modern alpine ski equipment, data from balance studies in laboratory conditions, etc., gave us a reason to experiment with a new methodological approach to build initial alpine skiing skills. This study aimed to investigate the effectiveness of a modified methodology for the formation of beginning alpine skiing skills in National Sports Academy "Vassil Levski" (NSA) snow sports courses. Tasks were set to conceptually follow the design as well as the subject and object of the study. Some of the methods used are pedagogical experiments and statistical measurements. The evaluation system is refined by deriving additional criteria to objectify the expert evaluation. In the pedagogical experiment with static reliability, the positively modified methodology of initial training in the alpine skiing technique was evaluated. In the new methodological approach, the alpine skiing skills coordinated with vertical movements are not taught. The presented results demonstrate the effectiveness of the modified training in terms of the acquisition of basic alpine skiing skills; adaptation to ski equipment, stance, balance, ski pointing and control, speed control, errors, etc.

Keywords: *new approach, efficiency, skill building,*

INTRODUCTION

Alpine skiing has its centuries of popularity. The origin of training and the first teaching methods in snow sports (Yankov, 2009) notes the existence of primitive training (ancient technique). The historical development of training methodologies in skiing has gone through many stages. In the beginning, the need to use them as a means of livelihood, and later as mobile sports equipment in the military. The way of training was influenced later by the improvement of ski equipment, the style of champions, and the emergence of new snow sports and disciplines. Other significant factors influencing current trends in ski teaching are the development of the ski industry and especially the active work of the world professional association of snow sports teachers, INTERSKI. In Bulgaria, we would note one significant aspect in the contribution of the development of methods for initial ski teaching, namely the excellent interaction between scientific approach, application, and professional expertise. Todorov et al., (2015) interject the good cooperation between the state municipal institutions and the Bulgarian Ski Federation in the features and specifics of ski education for children. Whether it is researching historical accounts of elementary teaching methodologies at different ages or leading-edge contemporary world concepts, modern skiing always stands out in this area. The reasons can be various: the seasonality of the sport and the eagerness of the lovers to experience the popular sport every year; visiting different ski destinations and the opportunity to spend leisure time with a favorite sport in nature in a healthy way; the powerful marketing impact of the winter tourism industry on millions of users of this type of sports tourism service; the observation of competitions of different ranks and others. In fact, the high ratings and competition in this winter sport make experts follow and implement effective training systems and adapt the same in national, regional, age, slopes, equipment, physical ability, and other distinctive features. One current example in this direction is the European Union's "ski easy" project under the Erasmus+ program. In this project, specialists are developing an easier and more accessible methodology for starting skiing lessons with specially manufactured ski equipment.

The current project's Partners are "Bulgarian Ski School Association" with representatives from the National Ski Academy "Vassil Levski". The formation of the concept of the present project is also the result of many years of international expert activity. The authors (Zgurovski, Simeonov, 2020) point to a number of international events discussing the need for a change in the methodology of initial training in the alpine skiing technique. Convincing support of the thesis of the development is the successful finalization of the institutional research project 2021 with the leading organization National Sports Academy "Vassil Levski" (NSA). In it, participants using innovative tools investigated equilibrium stability in beginner skiers of different ages and achieved results with added value for the present project.

AIM AND OBJECTIVES OF THE STUDY

Purpose: To determine the effectiveness of a modified methodology for initial alpine ski instruction with NSA students in Snow sports courses.

Objectives:

- Derivation of expertise determining relevance and applicability in a modified methodology for initial training in alpine skiing technique.
- Development of a modified methodology for initial training in alpine ski technique;
- Refinement of the system of expert evaluation of skiing skills;
- Conduct a pedagogical experiment to establish the effectiveness of the modified methodology.

RESEARCH METHODOLOGY

The scope of the study includes the period from 03.01.2022 to 22.03.2022. A total of 100 university students from the faculties of Sport, Pedagogy, and Kinesitherapy studying full-time and part-time were included in the study. They were randomly divided 50 each into control and experimental group and gender. The condition was that the subjects were unskilled in the alpine skiing technique.

The object was the methodology of initial training in the alpine skiing technique.

The methods used were: pedagogical experiment; expert evaluation in the field, as the results of each expert were recorded on protocols. Statistical processing of data, which includes analysis of variance of selected indicators. Comparative analysis of the test results obtained using Student's t-criteria. The statistical sample satisfies the requirements for the normal distribution of experimental data - a coefficient of variation lower than 30%.

The expert discussion allowed additional criteria for assessing alpine skiing skills, which are used as a basis for a "final average score". The same were used in the applied analysis of variance.

RESULTS

In two INTER Congresses, three International Ski Congresses, two seminars, and a research project, we presented new conceptual, methodological approaches for beginners in alpine skiing techniques. The positive results of the discussion allowed us to develop a draft of a modified methodology for the initial training of alpine skiing skills. After discussing with specialists in the field to objectify the expert evaluation of alpine skiing skills, an evaluation system based on additional derived criteria was developed.

Table 1. *Additional evaluation criteria*

Straight running downhill			**Snow ploughing**			**Snow plough turning**			**Diagonal descent**			**Snow plough turning(elementary)**		
Control of the skis	Distribution of the weight	Posture	Ski and speed control	Distribution of the weight	Posture	Control of the skis	Shifting the weight	Posture	Control of the skis	Distribution of the weight	Alpine behavior	Diagonal descent	The transition from diagonal descent to snow plough turning	The transition from Snow plough turning to diagonal descent

Table 1 shows the format of the test protocols according to which the skills of the control and experimental groups were evaluated. Each technical element (exercise) is presented in detail with evaluation criteria according to a six-point system to the decimal place. In our opinion, in this way, the objectification of the evaluation procedure of the subjects was achieved. Three experts score each item, with the final score being an arithmetic average.

We present a description of the modified methodology. We do not recommend "folding" and "unfolding" exercises as "first steps".

Through the familiar exercises for getting used to ski boots, greater freedom in the ankle joints is achieved (loose stirrups; adjustment, if possible, to the walkover system). In the types of ascent, particular attention is paid to step ascent to build an alpine stance. It is built by both ascending and descending stepwise. In the other elements (walking and turning) and the exercises without skis, the basic skiing posture (neutral) is formed. Coordination tasks are simplified as motor skills are gradually formed with limited involvement of the ankle joints.

Straight descent forms the dynamic balance (hori-

zontal), frontal and lateral. Low, medium and high stances are not studied. Front, middle, and back strapping exercises are used to build frontal balance by tightening the shoes and restricting freedom in the ankle joints.

Snow plough - in the initial learning, the half plough is learned first. For this purpose, the same terrain is used for speed control as for learning a straight descent (gentle, gentle slope). After that, the snow and braking plough is progressed. For refinement - moving from straight downhill to snow ploughing by not using high easing and opening the skis into a plough is aided by moving forward into a forward strain.

The plough arc is simplified as the main purpose of the element, namely the change of direction, is done by transferring the weight from one skeg to the other. We are not teaching "easing" and folding control here. Again, we recommend an accessible approach such as: picking a gentle slope; learning to half plow on gentle terrain from a starting position: skis in half plow along the slope line; perform rhythmic deflections near the slope line (small deflections). The weight transfer is done with a tilt from the shoulders to the outside skis (a side bend is obtained). Attempts can be made to assist the weight transfer with counter rotation.

Diagonal descent is to be learnt with skis in a half plough, thus providing greater support (stability among beginners) and easy formation of an alpine stance. Then transition to parallel skiing with the familiar methodical approach to learning and perfecting diagonal descent.

A basic rough shape turns to be learned with the familiar methodical approach saving the high easing and folding control. Here a methodical approach could be to learn in the diagonal descent: ski in half-plough, finish in plough before the turn, then transition to half-plough after crossing the slope line. In the consolidation and refinement phase, use parallel skis in the diagonal descent and classic execution of the basic turn. As a refinement at a later stage, perform the basic turn with a half plough.

A brief description of the new methodological approach was used in the training of students in the experimental group. The following results of the pedagogical experiment were achieved.

Table 2. *Variance analysis of experimental and control groups.*

Index	Experimental group	Control group	Absolute difference d	Difference percentage d[%]	t	Pt
Control of the skis/ Straight running downhill	5.38	4.35	1.03	19.2	8.2	100
Distribution of the weight/Straight running downhill	5.51	4.42	1.09	19.8	10.4	100
Posture /Straight running downhill	5.48	4.45	1.03	18.8	8.8	100
Ski and speed control/ Snow ploughing	5.47	4.33	1.14	20.9	8.6	100
Distribution of the weight /Snow ploughing	6.76	4.32	2.44	36.1	2.0	94.8
Posture /Snow ploughing	5.38	4.40	0.98	18.2	7.5	100
Control of the skis /Snow plough turning	5.34	4.46	0.88	16.4	8.1	100
Shifting the weight/Snow plough turning	5.43	5.38	0.05	0.9	0.0	3.9
Posture/Snow plough turning	5.33	4.27	1.06	19.9	10.0	100
Control of the skis/Diagonal descent	5.22	4.10	1.12	21.5	10.7	100
Distribution of the weight/ Diagonal descent	5.28	4.12	1.15	21.9	10.6	100
Alpine behavior	5.31	4.09	1.21	22.9	11.2	100
Basic turn diagonally	5.35	4.08	1.27	23.7	11.5	100
The transition from diagonal descent to snow plough turning	5.45	4.20	1.24	22.8	10.7	100
The transition from Snow plough turning to diagonal descent	5.43	4.20	1.22	22.6	11.2	100

Table 2 outlines the evaluation criteria for the control and experimental group. From these, it is evident that the experimental group's alpine skiing skill scores had higher values than the control group. For the research indicators where the variance guarantee reaches and exceeds 95%, it can be stated with complete confidence that the experimental results are significant, and the null statistical hypothesis of no significance is rejected. Thus, it can be claimed that the modified methodology applied is more effective than the current methodology of the Bulgarian Ski School used in the Snow Sports course at the NSA Vassil Levski. For better orientation, some basic alpine skiing skills (criteria) are presented in Figures 1 and 2.

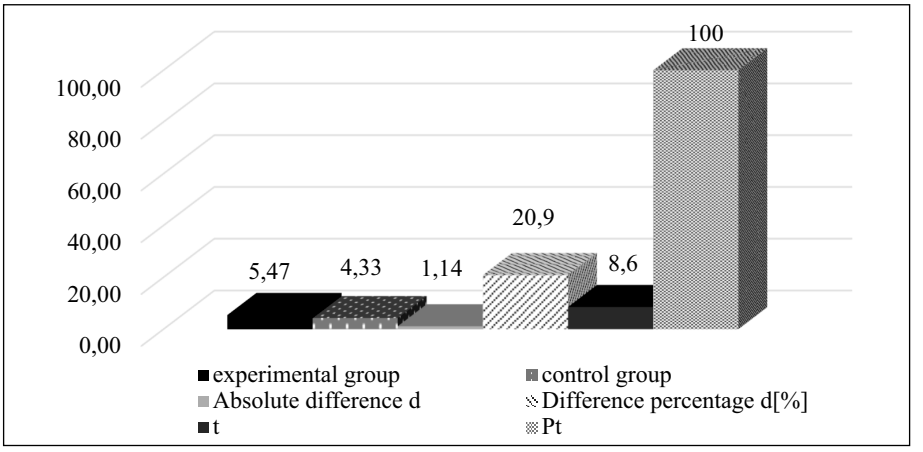

Figure 1. *Control of the skis*

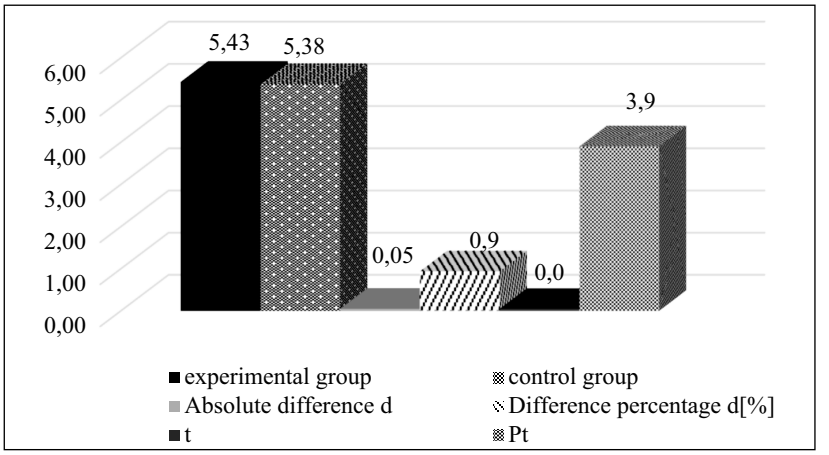

Figure 2. *Shifting the weight*

(Figure 1) shows a significant difference in the learned skill "speed control" with a positive result in favor of the experimental group. This trend is observed for all other studied indicators (skills) except the transfer of severity (Figure 2). Apparently, the new methodological approach did not significantly affect this basic skill. The existing problem for beginner skiers - difficult weight transfer to the awkward leg is significant in the training methodology. Still, here again, the modified approach positively interfered with the experimental group.

DISCUSSION

The results obtained from applying the modified methodology for initial training in the alpine skiing technique prove its effective practical use. The new methodological approach is easier and more accessible for students participating in snow sports courses to learn alpine skiing skills.

The methodology is in line with the current trends in ski teaching and is responsible for the safety of the lessons. The study of specialized sources presenting training systems of leading schools (Walte, 2018) (Pohl et al., 2019) (Lesnik, Zvan, 2007) and of the Bulgarian Ski School Association (Zgurovski, 2007) show similar ski motor training tasks that are not in the presented methodology.

This is the case of vertical movements that make it difficult for beginner skiers. This problem has al-

ready been discussed in lectures and workshops at several world professional events with Bulgarian participation. The research project cited above and the proven negative impact of vertical movement on balance in beginner skiers at any age give us reason to assume that the presented methodology is applicable not only to NSA students but to all categories of learners.

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REFERENCES

Zgurovski, Kr., Yankov, P. (2007). *Alpiyska ski tehnika*. Sofia. Dedraks // Згуровски, Кр. Янков, П. (2007). *Алпийска ски техника*. София. Дедракс

Todorov, D., Machirski, A., Velcheva, D. (2015). Osobenosti i spetsifika na obuchenieto po ski na PP Vitosha za detsa ot 3 do 6 godini. *Sport i nauka,* izvanreden broy 2 p. 3-9.// Тодоров, Д., Мачирски, А., Велчева, Д. (2015). Особености и специфика на обучението по ски на ПП Витоша за деца от 3 до 6 години. *Спорт и наука*, извънреден брой 2 стр. 3-9.

Yankov P. (2009). *Istorichesko razvitie na metodikite za obuchenie v snezhnite sportove.* Monografia. Sofia. NSA// Янков П. (2009). *Историческо развитие на методиките за обучение в снежните спортове.* Монография. София. НСА.

BRITITSH ASSOCIATION OF SNOWSPORT INSTRUCTORS (2006). *The basic manual.*

Hoppichler, F. (1980). *Die Osterreichische skischule.*

Lesnik, B. & Zvan, M. (2007). *Nase smucine alpskega smucanja.*

Walter, R. (2018). OSTERREICHISCHER SKICHULVERBAND., Vom einsteg zur perfection in vier stufen zum erfolg. Snowsport Ausria.

Pohl, W., Holzmann, M., Reinhardt, F., Haslach, N. (2019). *Ski fahren und unterrichten*. Deutscher skilehrerverband.

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INFLUENCE OF OLYMPIC WEIGHTLIFTING TRAINING ON MOTOR ABILITIES IN CHILDREN

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ABSTRACT
Introduction. One of the main goals of the Olympic weightlifting training process is to ensure a healthy motor training regime. Those activities are aimed at achieving tangible positive effects on the body, as well as providing adequate conditions for the physical development of trainees. Preparation under professional coaching in sports clubs guarantees the achievement of good sports performance. Methodology. The goal of this study is to identify the changes that occur in the physical performance of children (boys), under the influence of specialized training with the means of Olympic weightlifting. Eighteen (18) weightlifters aged 13 participated in the experiment. The study was conducted in two stages: the baseline data were collected in June 2020, and the final measurements were in June 2022. Results. Based on the results, we can conclude that the structured, specialized Olympic weightlifting training protocol positively affects explosive strength of lower limbs, speed, and flexibility in 13-year-old children. Discussion and conclusions. Habitual Olympic weightlifting training is not a very popular activity among children. It is generally considered risky and not appropriate for youngsters. However, our results painted a different picture, and based on them and our practical experience, in our opinion, if the methodology is properly modified, Olympic weightlifting is a powerful tool for the development of motor abilities in children.

Keywords: *Olympic weightlifting, children, motor abilities*

INTRODUCTION

Olympic weightlifting is a highly demanding sports discipline in terms of motor abilities development. As the variety of applied exercises is significant, along with the sports-specific skills, athletes must develop their special physical fitness as well. Special attention should be put on lagging muscle groups (Panayotov, 2018). Resistance training is a powerful tool for the healthy development of the human body and increasing its strength, speed, agility, and flexibility.

According to Abadjiev & Furnadjiev (1986), Gurkov (1992), and Gurkov & Dimitrov, (1992), to reach high sports results, developing solely muscle strength and power is far from enough, but athletes also must build a strong-willed character. Additionally, training motor abilities such as speed, coordination, base and strength endurance, joint mobility, etc., is of great importance too. Most novice weightlifters lack adequate physical development, so their potential for reaching great results is limited. Developing the most important muscle groups in Olympic weightlifting, whole body speed, and agility, and hip joint mobility, is especially important to achieving great performance.

According to Soboleva (1997), sports-specific training stimulates early physical, functional, and pubertal growth and maturation, and early sports specialization is an important prerequisite for the long process of training champions.

According to Zatsiorski (1970), achieving an adequate balance between motor abilities is a consequence of the interrelationship between the applied physical training and the level of physical fitness of the athlete. In strength and power sports, the correlations between the sports-specific physical abilities increase with biological and training age.

As early sports specialization became mainstream in Olympic weightlifting in recent decades, it is important to investigate the effects of specific resistance training on the whole-body development and maturation of young athletes.

AIM AND OBJECTIVES OF THE STUDY

This research aims to study the effects of the standard Olympic weightlifting training program used in Bulgarian sports clubs on changes in physical fitness in 13-year-old boys.

To achieve this aim, we set the following objectives:

1. To recruit a group of 13-year-old weightlifters and measure their baseline physical fitness parameters.
2. To implement the standard Bulgarian Olympic weightlifting training protocol in the subject group for two years.
3. To measure the final values of the studied physical fitness parameters of the study subjects.
4. To analyze the within-group differences in studied parameters after the end of the experiment.

METHODS

Entity sample

To study changes in physical fitness, we recruited a random group of 18 13-year-old boys practicing Olympic weightlifting from different sports clubs in Bulgaria. We conducted a testing procedure to assess several parameters of physical fitness. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

Procedures

The Olympic weightlifting training methodology consisted of two sessions per week that included primarily the competitive movements, along with several auxiliary exercises such as the power clean, power snatch, and front or back squat. This is a standard methodology in Bulgarian Olympic weightlifting clubs, developed by Gurkov & Dimitrov (1992). The study was conducted in two stages: baseline data were collected in June 2020, and final data – in June 2022. The overall duration of the experiment was 24 months.

Testing

The following tests were performed to measure the physical fitness of the participants:

1. 30-m acceleration running (sec.) as a measure of speed.
2. Sit-ups (number per 60 sec.) as a measure of speed/strength endurance.
3. Push-ups (number per 30 sec.) as a measure of speed/strength endurance.
4. Standing long jump (cm.) as a measure of explosive strength.
5. Throwing a solid ball with two hands over the head (cm.) as a measure of explosive strength.
6. Standing high jump (cm.) as a measure of explosive strength.
7. Forward bending (cm.) as a measure of flexibility.

Statistical analysis

We used the paired samples Student's t-test procedure to evaluate the within-group differences of studied parameters in the group of participants at a level of statistical significance of $p < .05$.

RESULTS

The longitudinal effects of the standard Olympic weightlifting training methodology on the first 3 studied physical fitness parameters in 13-year-old children are presented in Figure 1.

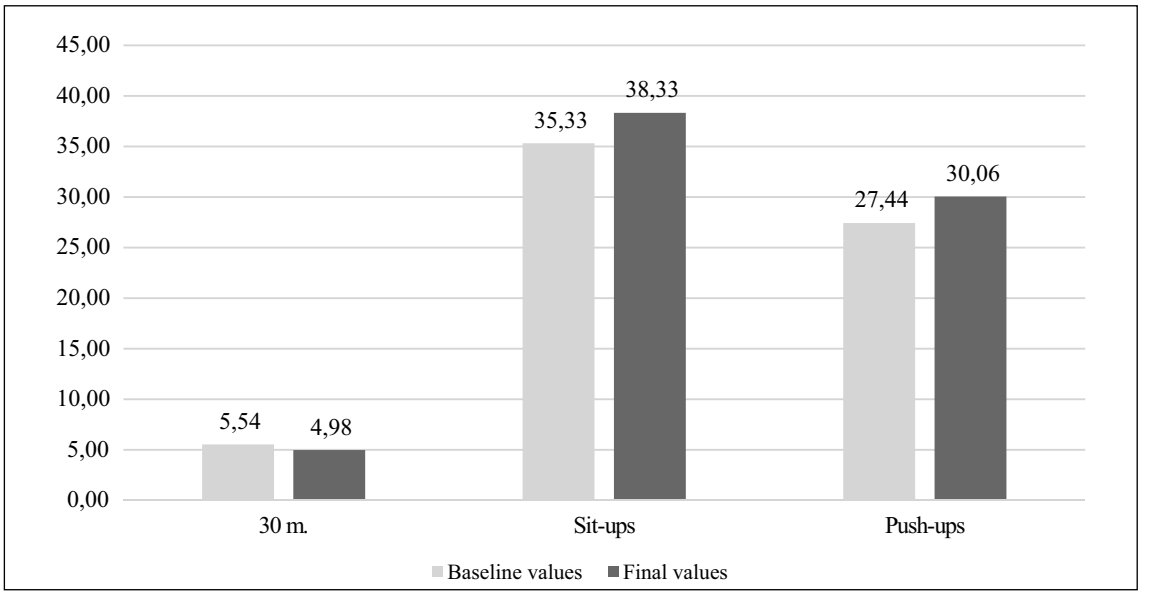

Figure 1. *Baseline and final mean values of the studied parameters (30-m acceleration, sit-ups, and push-ups).*

As shown in Figure 1, all three variables improve in value after two years of regular weightlifting-style resistance training. The largest increase is measured in the number of successful sit-ups (3.00), followed by the push-ups (2.6). The decrease in the time of the 30 m. acceleration running test is 0.56 s. According to some authors, acceleration and sprint running improves basic speed and explosiveness (Gurkov & Dimitrov, 1992).

In figure 2, we present the changes in the results of the remaining four physical fitness tests – standing long jump, throwing a solid ball with two hands over the head, standing high jump, and forward bends. The largest difference is in the second test (which measures the whole body explosiveness) – 77,11 cm. The other three parameters also improve: standing long jump – 21.22 cm., standing high jump – 4.72 cm. and forward bending – 1.44 cm.

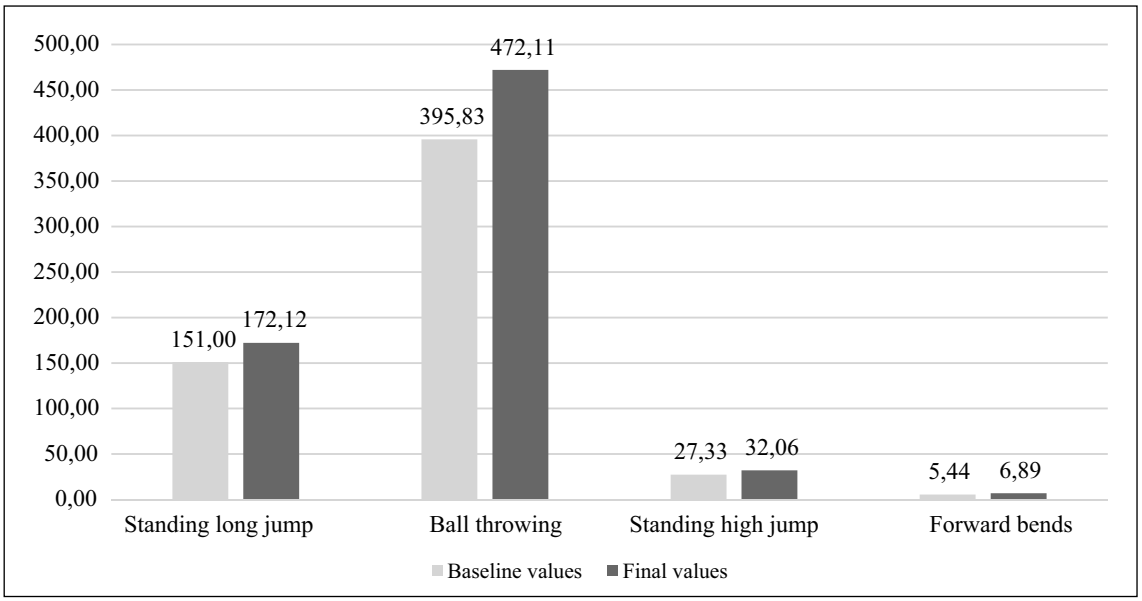

Figure 2. *Baseline and final mean values of the studied parameters (standing long jump, throwing a solid ball with two hands over the head, standing high jump, and forward bending).*

In Table 1, we represent the descriptive statistics of the baseline and final values of the studied physical fitness parameters.

Table 1. *Descriptive statistics of studied parameters*

		Mean	N	Std. Deviation	Std. Error Mean
30 m. acceleration	final	4.985	18	.381	0.089
	baseline	5.540	18	.321	0.0758
Sit-ups	final	38.33	18	4.971	1.172
	baseline	35.33	18	5.520	1.301
Push-ups	final	30.06	18	6.384	1.505
	baseline	27.44	18	6.373	1.502
Long jump	final	172.22	18	5.887	1.388
	baseline	151.00	18	8.374	1.974
Ball throw	final	472.94	18	20.325	4.791
	baseline	395.83	18	25.426	5.993
High 4.72jump	final	32.06	18	3.948	0.931
	baseline	27.33	18	4.352	1.026
Bending	final	6.89	18	1.811	0.427
	baseline	5.44	18	1.294	0.305

Table 2 presents the correlation coefficients of the studied pairs. All values are very high and statistically significant, which denotes almost functional relations between initial and final values of the parameters. This proves that the studied methodology imposed very consistent effects upon all analyzed motor abilities and their development strongly depends on their initial values.

Table 2. *Paired samples correlations in studied parameters*

		N	Correlation	Sig.
Pair 1	30 m. acceleration	18	.551	.018
Pair 2	Sit-ups	18	.950	.000
Pair 3	Push-ups	18	.972	.000
Pair 4	Long-jump	18	.580	.012
Pair 5	Ball throw	18	.754	.000
Pair 6	High jump	18	.940	.000
Pair 7	Bending	18	.700	.001

In Table 3, we represent the within-group differences in studied variables assessed by the paired samples Student's t-test procedure. All differences are highly statistically significant, and for this reason, we did not correct for a family-wise error rate.

Table 3. *Paired samples t-tests between baseline and final values of studied parameters*

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
30 m. acceleration	-.555	.337	.079	-.723	-.3879	-6.992	17	.000
Sit-ups	3.000	1.749	.412	2.130	3.870	7.277	17	.000
Push-ups	2.611	1.501	.354	1.865	3.357	7.383	17	.000
Long-jump	21.222	6.899	1.626	17.791	24.653	13.05	17	.000
Ball throw	77.111	16.73	3.945	68.788	85.434	19.54	17	.000
High jump	4.722	1.487	.351	3.983	5.462	13.46	17	.000
Bending	1.444	1.294	.305	.801	2.088	4.738	17	.000

DISCUSSION

Yordanov (2015) studied the effects of a training program of complex exercises on the physical fitness of 13-year-old adolescents and reported a mean value of successful sit-ups of 21.5. In our study, this value at baseline is 11.5 higher – 33. In our opinion, this difference may be due to the higher routine physical activity combined with weightlifting-specific resistance exercises in our participants.

We used two tests to measure the explosive strength of lower limbs – standing long jump and standing high jump. Our results corroborate those of Dobrev (1983), Gurkov & Dimitrov (1992), which found a strong correlation between the results in these tests and those in the competitive movements in Olympic weightlifting – snatch and clean and jerk. The same conclusions are also valid for the "Throwing a solid ball with two hands over the head" test, which is positively correlated with results in the snatch. The improvement in explosive strength of lower limbs is also due to regular Olympic weightlifting-style resistance training. Similar results, although somewhat lower, are reported by other researchers (Boyanov & Yankova, 2009, Yankova, 2016). In our opinion, this finding supports the hypothesis that weightlifting-specific training and training age are the most important factors for performance in Olympic weightlifting. Although we did not assess the exact contribution of biological age to the increases in those parameters, we presume that it is only a secondary factor.

According to Slavova (2017), regular testing in sports is an important feedback control factor in the training process. It helps coaches assess athletes' progress, change training parameters if necessary and individualize the training process. Although

not presented in this study, our participants were regularly tested during the time of the experiment, and ongoing control of training parameters by coaches may be a factor in the results we measured.

In conclusion, the standard Olympic weightlifting methodology positively affects explosive strength of lower limbs, whole body explosive strength, speed, and flexibility in 13-year-old children in the long term. The adequate choice of exercises, training volume, and intensity are important factors of sports performance. Regular ongoing tests of physical fitness parameters should be performed to individualize the training program by controlling its short-term effects.

REFERENCES

Abadjiev, I. & Furnadjiev, V. (1986). *Podgotovka na tejkoatleta* [The preparation of the weightlifter]. MiF, Sofia

Boyanov, V. & Yankova N. (2009). Sravnitelen analiz i razlishia v individualnata podgotovka na kadetki, devoiki I jeni-tejkoatletki [Comparative analysis and differences in individual preparation of female cadets weightlifters]. *Sport i nauka*, 2, 19

Dobrev, D. (1983) *Silova, takticheska i voleva podgotovka na tejkoatleta* [Strength, tactical and will preparation of the wigthlifter]. ECNPKFKS

Gurkov, D. (1992). *Tejka atletika v detska i unosheska vazrast* [Weightlifting in juvenile and adolescent age]. ECNPKFKS

Gurkov, D. & Dimitrov, D. (1992). *Tejka atletika v detska i unosheska vazrast* [Weightlifting in juvenile and adolescent age]. Sofia

Panayotov, V. (2018). *Muskuli, Kulturizam, fitness, silova podgotovka* [Musccles, bodybuilding, fitness, strength training]. Sofia

Slavova, V. (2017). *Smeseno obuchenie. Principi, podhodi i praktiki* [Mixed education. Principles, approaches and practices]. Avangard Pres, Sofia

Soboleva, T. (1970). *Formirovanie polozavisimih harakteristik u devochek I devushek na fone zaniatii sportom* [Development of sex-related characteristics in sports-practicing girls]. Disertation, Moskow

Yordanov, V. (2015). Opredeliane na eksperimentalni i kontrolni grupi za izsledvane na fizicheskata deesposobnost na momcheta ot 5, 6 i 7 klas [Defining experimental and control groups of research physical fitness in 5-th, 6-th and 7-th grade]. *Nauchni trudove na RU*, 54, 115

Zatsiorski, V. (1970). *Fizicheskie kachestva sportsmen* [Physical abilities of the athlete]. Moskva

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MODERN PRACTICE AND METHODS FOR INTEGRATION THROUGH GOLF

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ABSTRACT
Summary: Introduction: Modern developed and civilized society is based on the principles of democracy, humanism, and pluralism. In his social center stands the person - the person with individual rights, duties, and responsibilities. People are born different, unique, with individual desires, opportunities, dreams, and interests, but with equal rights in society. Equality and the absence of any discrimination is a fundamental principle in advanced civil societies and social systems.
Methodology: In the research process, we have applied: informational research, document analysis, and historical analysis, conclusions, based on personal experience, monitoring, synthesis, and theoretical analysis.
Results: Based on this pilot study have been created practical recommendation for integration through golf.
Discussion: The results obtained suggest that golf can successfully enhance integration processes in society, as well as improve the social inclusion of all social groups at risk. Golf has immense potential for combating youth unemployment, provoking and developing the various social knowledge, skills, and competences that everyone needs, regardless of their social status, gender, race, or ethnicity.
Conclusion: It is of the utmost importance for society to continue to work on the topic by promoting and guaranteeing greater impact on problems and solutions in this area, promoting good practices for integration and social inclusion.

Keywords*: integration, adaptation, socialization, good practices, social exclusion*

INTRODUCTION

Modern developed and civilized society is based on the principles of democracy, humanism, and pluralism. In his social center stands the person - the person with individual rights, duties, and responsibilities. People are born different, unique, with individual desires, opportunities, dreams, and interests, but with equal rights in society. Equality and the absence of any discrimination is a fundamental principle in advanced civil societies and social systems.

In every society, there are people and groups who are marginalized for some reason - long-term unemployed, with different addictions (alcohol, gambling, illicit substances and stimulants, people with different types of disabilities or social problems, etc.), they exhibit characteristics that make them are different from generally accepted norms of behavior. We must not forget that they are part of society, they are among us, and we must accept them as equal persons, recognizing their right to be different. Of course, the power of this inclusion will be to a different extent, determined mainly by the individual characteristics of each of them, but let us not forget that the maturity of a society is determined by its attitude towards people with disability, irrelevant by their gender, race, social or economic status or ethnicity (Modified Rules of Golf for Players With Disabilities,2018). We claim to be a highly organized technological and civilized society that has the resources to care for the survival of people with disability. Unfortunately, this rarely happens. We need change and why should sports not be a catalyst for this metamorphosis? Sports can be the architect of our lives, it can build bridges where there are barriers or walls.

For hundreds of years, golf has inspired millions of people around the world (Damyanova,2001). Considered to be a gentleman's sports, golf makes it possible to build many qualities in practitioners. All the rules of golf are about justice, there are no referees in the game, and it relies on the honest word of the players. In addition to developing a driving culture, players also learn several life-relevant qualities such as discipline, fair play, and fairness (Amateur status,2018). This sport is one of the most popular in the world, and it greatly supports personal development through the development of skills such as concentration, coordination, discipline, honesty, respect for the opponent, teamwork skills, and proper behavior.

Golf has long become as a sport that not only brings pleasure and fun but is also a powerful tool and vehicle for social change. This sport is

practiced by everyone - men and women, poor and rich, of different ethnicity or religion, of people of different sexual orientations. Practice shows that more and more people with disability find the sports in golf, which brings them confidence, self-affirmation, motivation, and social contacts in our modern society (Modified Rules of Golf for Players with Disabilities,2018). Its practice does not discriminate different social groups. It builds bridges between different groups and persons at risk of social exclusion. From the perspective of people with disabilities, this sport is an ideal tool for social integration (Damyanova, 2005). And here we have to ask ourselves - what are the best tools and models for integration? Can the practice of golf or adapted physical activity support and/or improve the process of social integration?

According to various professionals who work with people at risk of social exclusion and disadvantaged or at-risk youth, systematic and focused sports activities have a positive effect on their social adaptation. They have noticed that regular and focused physical activity brings educational benefits because of the values it promotes - respect, tolerance, and self-control. Sports can lead to positive social change and can be used as a tool for prevention and education on topics such as socialization, integration, discrimination, racism, and violence. There is thousands of evidence of how sports can create bridges where boundaries usually exist, giving participants a lesson in teamwork, empathy and empathy for their teammates, and respect for their opponents and opponents. Sports teach essential life skills for goal setting, develop a strong sense of ethics, behavior, and morality, and provoke a positive diversity development. (Damyanova, 2007).

The aim of the study

This pilot study aims to clarify the mechanisms and the interested individuals and legal entities from the successful implementation of programs for socialization, social adaptation, and integration through golf for persons at risk of social exclusion. The objectives of the study

The subject of the research are the attitudes and desire for integration, lasting social adaptation, and re-socialization through golf among the respondents.

METHODS

To be as accurate as possible in the results presented in this study, we have combined diverse data collection methods that could be synthesized into the following groups - structural content analysis, good practice analysis, S.W.O.T analysis, and statistically one-dimensional frequency analysis. (f - absolute frequencies, w = f / n * 100 - relative frequency in percent), questionnaire survey.

RESULTS

According to a 2016 National Statistics Institute on Poverty and Social Inclusion survey, over 40% of our population is at risk or at risk of poverty or social exclusion, which equates to around 3 million people (NSI, 2018). The same survey shows that, statistically speaking, golf clubs in Bulgaria are at key places and can assist with appropriate programs with appropriate national funding for the processes and policies for integration, socialization, and even economic prosperity in these areas. In the northeast region, more than 450,000 people are at risk of social exclusion lives, and there are three exceptionally well-functioning golf clubs - Lighthouse Golf Resort, Black Sea Rama, and Thracian Cliffs. In the southwestern region, the number of people at risk of poverty and social exclusion is even greater - over 740 thousand people. There are also three golf clubs in the area - Pirin Golf, Pravets Golf, and St.Sofia GolfClub & SPA, which have a large and modern base, staff of experienced professionals, and the necessary skills to engage in initiatives and programs for integration, socialization, and adaptation of endangered persons and groups of the population (Golf courses, 2018).

Based on the processed results, we conducted S.W.O.T - an analysis of the opportunities and prospects for golf development as a tool for integration and introduction of good practices for golf integration in Bulgaria (Table 1).

Table 1. *S.W.O.T analysis*

Strengths	**Weaknesses**
In many places, the golf complexes have a SPA center - a condition for the development of combined prevention, rehabilitation, and treatment through sports. Prices of golf services in Bulgaria are lower than in other European golf destinations. Bulgaria's EU membership contributes to the development of golf in Bulgaria, including as a tool for socialization and adaptation. Golf has a strong social function and generates high income for charity. Golf encourages the attraction of foreign investment in the public and private sectors. Due to the more favorable natural, climatic, economic, and financial conditions, Bulgaria is a potentially more attractive golf destination. Natural landscapes surround many golf courses in our country.	Bulgaria maintains a low standard of living, and golf is still an expensive sport, making it inaccessible to a large part of the Bulgarian population. There is insufficient advertising and promotion, which is a minus for the development of the sport of golf in our country. There is still not enough trained and qualified personnel in golf complexes, especially regarding the use of sport as an integration tool. The state does not invest in golf projects, or its financial support is insufficient. The capital investment needed to build a golf complex is huge, and the return is slow and time-consuming. High costs during the summer for irrigation and maintenance of lawns in golf complexes.
Opportunities	**Threats**
Hosting more golf tournaments with world renown at golf courses in Bulgaria. Promoting golf as a sport in Bulgaria among the local population and golf players worldwide. Promoting golf lessons among children. Improvement of advertising and promotion of golf in Bulgaria. Establishment of a state plan and strategy for the construction of golf courses in underdeveloped economic areas and natural areas.	The high cost of golf services. A prerequisite for the emergence of some environmental issues (noise and traffic congestion, shocking visual landscapes, destroying homes and breeding grounds, and food sources for a wide range of plants, animals, and insects). Low rate of operation of golf courses and complexes in Bulgaria. Bankruptcy risk and non-return on investments.

Conclusions from S.W.O.T analysis:

- There is a lack of significant national financial resources that support golf integration in Bulgaria;
- The lack of a legal framework for golf integration hinders the adaptation and socialization of significant groups of people;
- The lack of a sufficient number of qualified staff employed to deal with mental, physical, or sensor disabilities in golf clubs demotivates significant social groups;
- Insufficient funding and public policy limits golf clubs in dealing with these social groups;
- One of the ways to promote Bulgaria as a tourist destination is through golf as a tool for social, prophylactic, sports, cultural and biomedical tourism;
- Integration through sports, and in particular through golf, would increase the social and economic activity of the population and, in a huge number of cases, would have a positive effect on entire regions of the country investments, increased employment levels, development of a tourist destination, increased corporate social responsibility and donation.

A special questionnaire was developed in Bulgarian to collect the necessary empirical data, consisting of 13 closed-ended questions. A survey of attitudes to the needs of methodologies and programs that use golf as a tool for socialization and adaptation of people with disability was conducted among 95 people (N = 95). These include 31 women and 64 men.

Different data has been revealed in the following parts of the current research such as:

- Respondents have a direct bearing on the need for processes and methods of integration and socialization of their close friends, relatives, or acquaintances. Such connection is shown by nearly ¾ of the answers (76.8%) - strong commitment of the persons who answered the

question with a positive answer;
- Among the risks identified by the respondents to people with disability with the highest priority are social exclusion (21.7%), depression (19.9%), and less opportunity for these people to start a new job (19.2 %). All these factors, together with the risk of poverty (17.1%), show the clear need for well-functioning and practically effective integration and social inclusion programs;
- Most of the respondents believe that golf can influence as a catalyst for social change (78.9%) - evidence that a significant part of our society believes in the integration possibilities of this sport;
- Most respondents (88.4%) did not participate or are unaware of programs that use golf as an integration tool, despite their strong involvement and interest in the topic;
- The respondents answered that they would participate in a program using golf as a tool for social integration (82.8%).

DISCUSSION

The results suggest that golf can successfully enhance integration processes in society and improve the social inclusion of all social groups at risk. Golf has immense potential for combating youth unemployment, provoking and developing the various social knowledge, skills, and competencies everyone needs, regardless of their social status, gender, race, or ethnicity.

At the same time, the survey identified numerous barriers faced by people with disabilities, refugees, migrants, children with special educational needs, the long-term unemployed, or other groups at risk of being socially excluded if they wish to participate in sports or physical activity. These include cultural and linguistic barriers, practical and financial constraints, and a lack of appropriate sports programs.

Based on the research, we have formulated the following conclusions:
- It is clear that there are good practice models that use golf as an integration tool and recommendations need to be developed to encourage increased participation of affected groups in sport and physical activity;
- Through golf, we can successfully increase the integration processes in society and improve the social inclusion of all social groups at risk;
- Golf has immense potential for combating youth unemployment, provoking and developing the various social knowledge, skills, and competencies that everyone needs, regardless of their social status, gender, race, or ethnicity;
- We must use the role that sport can play in strengthening communities and promoting inclusion;
- Promote tailored sports and leisure programs that can easily affect the physical and mental health of participants;
- To motivate physical activity and a healthy lifestyle through sports;
- A coordinated and integrated approach between state and non-governmental organizations (state and local authorities, non-governmental organizations, and the sports sector / including sports federations and sports clubs) is needed to address such challenges to the integration and socialization of persons at risk of social exclusion;
- Participation in physical activity and sports has numerous health benefits, both physically (such as improving health and reducing the risk of chronic diseases) and psychologically (such as building the right social and personal qualities, countering stress and depression, increasing self-esteem, discipline, and organizational capabilities);
- The study outlines the social benefits of sport, noting that increased participation in sport can help reduce crime and anti-social behavior, and deviant behavior and build social cohesion
- Golf is a common language that can be used as a tool useful and effective for integration into society, which can foster and, along with education, bring values such as tolerance, freedom, justice, respect, etc.;
- Golf helps break stereotypes, facilitating the process of integration of immigrants and minorities in society and promoting mutual understanding and dialogue between cultures. It is a universal language and facilitates the process of social inclusion;
- Golf does not discriminate on any grounds, such as gender, race, color, ethnic or social background, genetic traits, language, religion or belief, disability, age, or sexual orientation.

After completing this study, we can make the following recommendations:
- Financing state programs that use the sport of golf for treatment, rehabilitation, rehabilitation, and prevention at the Ministry of Défense, National Intelligence Service, National Security Service, and Ministry of Interior;

- Local and national authorities to encourage interest in sports organizations and professionals in creating sustainable programs for integration through sport and, in particular, sport golf as a unique and powerful tool for socialization and the development of personal and social qualities;
- Provide a more significant opportunity for young people to exchange ideas and experiences on the topic and thus increase the added value of local communities in the processes of integration and combating multicultural differences;
- Increase knowledge and acquire new skills, knowledge, and methods for sports and outdoor activities as tools for integration and education;
- Golf clubs, municipal, regional and national authorities, and ministries to clarify the problems and challenges facing sport and golf in particular as a tool for integration and education in content and methodology in the process of non-formal learning, intercultural differences, and influencing the local community;
- Raising awareness of the personal, social and professional realization of participants in such integration programs;
- Improving the provision of information on poverty and social exclusion policies in terms of their causes, dimensions, and manifestations;
- Study and exchange of good practices between the EU Member States and stakeholders at the national and local level to tackle poverty and social exclusion;
- Strengthening dialogue and stakeholder consultation on poverty and social exclusion;
- Introduce social impact assessment in all policy areas, incl. and conducting independent social impact assessments on a regular basis;
- Implementation of targeted program and project financing for the activities of state and non-governmental sports organizations using sport golf as a tool for social change and socialization and working with citizens and individuals at risk of social exclusion, which would have a significant impact on enhancing the safety and well-being of local people community.

We need to focus on new methods, approaches, and systems that will benefit our societies because we believe that to tackle issues like poverty, unemployment, and social inequality, it is important to use the universal language of sport. This language can unite society and is a great and powerful tool for integration. It is of the utmost importance for society to continue to work on the topic by promoting and guaranteeing a more significant impact on problems and solutions in this area, promoting good practices for integration and social inclusion. However, such methods should be reported at the state level and targeted, with specific national policies for obtaining a worthy place for sport as an integration tool that produces excellent results in many countries worldwide. In a globalized world, it is only through joint action that we have the opportunity to meet the impending social, cultural, ethnic, racial, environmental, economic, and security challenges. Let us, through the golf, transform negative emotions such as insecurity and a sense of powerlessness into new European ideas of democracy, integration, security, and pluralism.

REFERENCES

Amateur status. (2022). Retrieve from USGA: https://www.usga.org/rules-hub/amateur-status.html

Damyanova, Reny (2001). *Pravilata na Golfa*, Sofia Press, Sofia

Damyanova, Reny (2005), Naredbi na BGA/EGA, NSA Press, Sofia

Damyanova,Reny (2007), Pravilnik po golf, NSA Press, Sofia

Golf courses. (2022). Retrieve from Golf. bg: http://golf-bg.com/golf-courses/index/bg

Modified Rules of Golf for Players With Disabilities. (2022). Retrieve from USGA: https://www.usga.org/rules/modified-rules-players-disabilities.html

NSI. (2022). Retrieve from NSI.bg: http://www.nsi.bg/

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EFFECTS OF OLYMPIC WEIGHTLIFTING TRAINING METHODS ON MOTOR ABILITIES IN 13-15-YEAR-OLD CADETS

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ABSTRACT
Introduction. The Olympic weightlifting training methodology is a powerful tool for developing motor abilities and overall fitness. In addition, it is well established that these activities have a positive effect on the physical development of adolescents. It is important that the preparation is conducted under professional coaching in sports clubs to guarantee the achievement of good sports performance without injuries. Methodology. The goal of this study is to identify the changes that occur in the physical performance of 13-15-year-old cadets (boys), under the influence of specialized training with the means of Olympic weightlifting. 30 weightlifters aged 14 on average participated in the experiment. The study was conducted in September 2021. Results. Based on the results, we can conclude that overall the structured specialized Olympic weightlifting training protocol positively affects explosive strength, speed, and flexibility in 13-15-year-old cadets. However, the results show significant between-group variability when stratified by age. Discussion and conclusions. Habitual Olympic weightlifting training is not a very popular activity among children and adolescents. It is generally considered risky and not appropriate for youngsters. However, our results painted a different picture, and based on them and our practical experience, in our opinion, if the methodology is properly modified, Olympic weightlifting is a powerful tool for the development of motor abilities in trainees of different age groups.

Keywords: *Olympic weightlifting, cadets, adolescents, motor abilities*

INTRODUCTION

Olympic weightlifting requires the development of various motor abilities such as maximal strength, explosive strength, speed, etc. The diversity of muscle effort used necessitates the inclusion in the training program not only of technical exercises but also of sport-specific resistance training. Special attention should be paid to avoiding muscle imbalances and training lagging muscle groups with priority (Panayotov, 2018). Olympic weightlifting type of resistance training is a powerful tool for increasing muscle strength, speed, agility and flexibility, as well as stimulating whole body development and maturation during puberty.

According to Abadjiev, Furnadjiev (1986), Gurkov (1992), and Gurkov, Dimitrov (1992), in order to achieve high sports results, athletes must have to develop not only their physical abilities but also build strong morale and will. In addition, the popular belief that increasing muscle strength is a sufficient prerequisite for elite performance is also a myth. Olympic weightlifters must also develop speed, coordination, basic and strength endurance, joint mobility and flexibility, etc. As expected, novice weightlifters have only very basic levels of most motor abilities, which greatly reduces their sports potential. The underdevelopment of the most important for Olympic weightlifting muscle groups reduced mobility and flexibility of the hip joints, and low speed and agility are the main obstacles to sports performance.

According to Soboleva (1997), sports-specific training stimulates early physical, functional and pubertal maturation, and early sports specialization combined with regular hard work are particularly important for elite performance in sports. In his early publications, Zatsiorsky (1970) states that the interdependence between motor abilities is a function of training and sports-specific work. In strength and power sports, the correlation between the sports-specific physical abilities increases with the age and qualification of the athlete.

Aim and objectives of the study

The aim of the study was to monitor changes in physical fitness in 13-15-year-old cadets training regularly Olympic weightlifting.
The objectives of the study were:

1. To recruit a group of 13-15-year-old weightlifters and measure their basic parameters of physical fitness.
2. To analyze the overall physical fitness of study participants.

3. To compare the studied parameters of physical fitness between athletes of different ages.

METHODS

Entity sample

To study changes in physical fitness, we recruited a random group of 30 13-, 14- and 15-year-old cadets training Olympic weightlifting from different sports clubs in Bulgaria and conducted a testing procedure to assess several parameters of physical fitness. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

Procedures

The Olympic weightlifting training methodology consisted of five double-split sessions per week that included primarily the competitive movements, along with several auxiliary exercises such as the power clean, power snatch, and front or back squat. This is a standard methodology in Bulgarian Olympic weightlifting clubs, developed by Gurkov, and Dimitrov (1992). The study was conducted in September 2021.

Testing

The following tests were performed to measure the physical fitness of the participants:

1. 30-m acceleration running (sec.) as a measure of speed.
2. Sit-ups (number per 60 sec.) as a measure of speed/strength endurance.
3. Push-ups (number per 30 sec.) as a measure of speed/strength endurance.
4. Standing long jump (cm.) as a measure of explosive strength.
5. Throwing a solid ball with two hands over the head (cm.) as a measure of explosive strength.
6. Standing high jump (cm.) as a measure of explosive strength.
7. Forward bending (cm.) as a measure of flexibility.

Statistical analysis

We used comparative statistical analysis and exploratory statistics to analyze our data set.

RESULTS

The results of the first three physical fitness tests are presented in Figure 1 and Table 1.

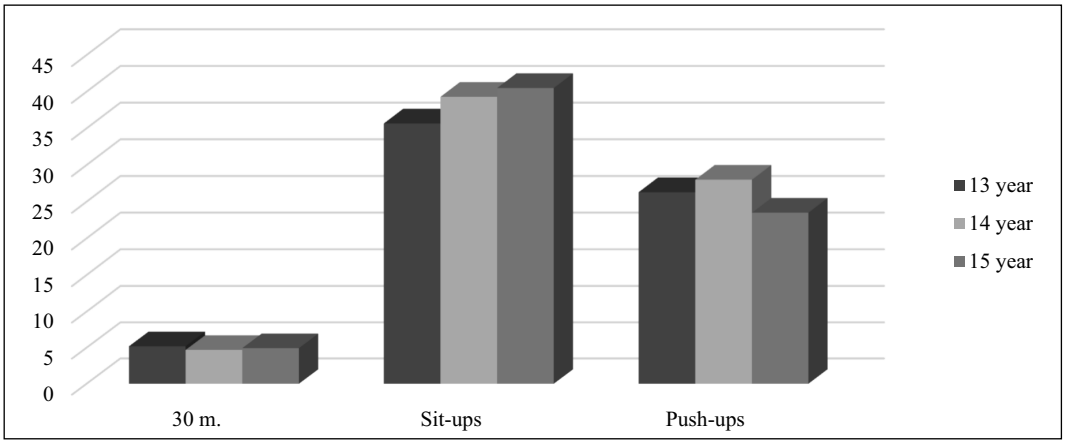

Figure 1. *Mean values of studied physical fitness parameters – 30 m. acceleration, sit-ups, and push-ups*

Table 1. *Mean values of studied physical fitness parameters – 30 m. acceleration, sit-ups, and push-ups*

	30 m. acceleration	**Sit-ups**	**Push-ups**
13-year-olds	5.2	35.7	26.3
14-year-olds	4.7	39.3	28
15-year-olds	4.9	40.5	23.5

As expected, the results of the first test, 30 m. acceleration running, improve with age and maturation. The cohort of 13-year-olds covers the distance in an average of 5.2 sec, the 14-year-old group in 4.7 sec, and the 15-year-old group in an average of 4.9 sec. According to Gurkov and Dimitrov (1992), sprint training improves basic speed and explosiveness and is therefore widely used in Olympic weightlifting.

In the sit-ups test, the same pattern is observed – 35.7 sit-ups for the 13-year-olds, 39.3 for the 14-year-olds, and 40.5 for the 15-year-olds. Interestingly, the 14-year-olds dominate in the push-

ups test with 28 push-ups on average, while the 13-year-olds and 15-year-olds have averages of 26.3 and 23.5 respectively.

Figure 2 and table 2 represent the results in the rest four tests – standing long jump, throwing a solid ball with two hands over the head, standing high jump, and forward bending.

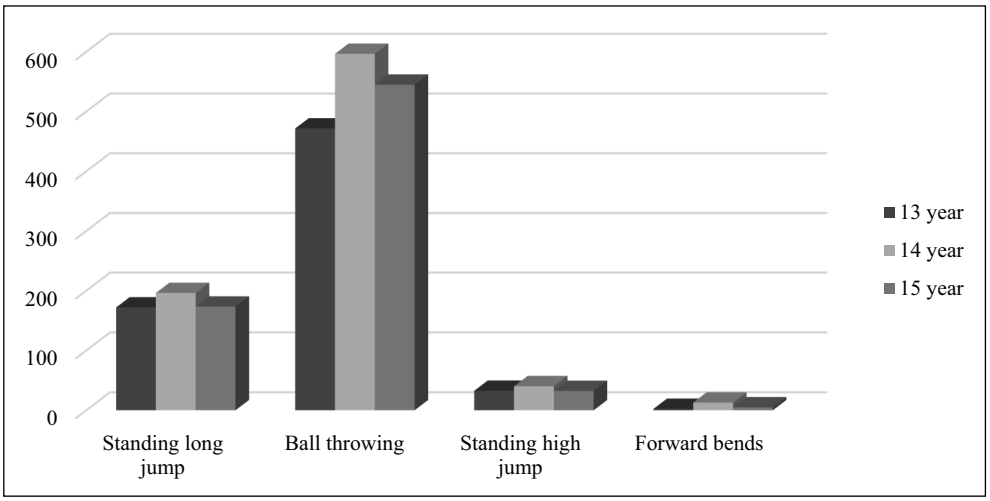

Figure 2. *Mean values of studied physical fitness parameters – standing long jump, throwing a solid ball with two hands over the head, standing high jump, and forward bending*

Table 2. *Mean values of studied physical fitness parameters – standing long jump, throwing a solid ball with two hands over the head, standing high jump, and forward bending*

	Standing long jump	**Ball throwing**	**Standing high jump**	**Forward bends**
13-year-olds	172	471.7	32.7	2.3
14-year-olds	196.3	596.7	40.3	13
15-year-olds	173.5	545	32.5	5

The 14-year-old athletes have the highest results in all four tests: standing long jump 196.3 cm, throwing a solid ball with two hands over the head – 596.7 cm, standing high jump – 40.3 cm, and forward bending – 13 cm. The 13- and 15-year-olds demonstrate similar physical abilities in these tests while, interestingly, the former group is even slightly better on the standing high jump test – 32.7 vs. 32.5 cm.

DISCUSSION

The two jump tests that we used are widely accepter markers of lower extremity explosive strength. In this regard, our results corroborate those of other researchers (Dobrev, 1983, Gurkov, Dimitrov, 1992) that there is a strong positive correlation between jumping ability and performance in the competitive movements of Olympic weightlifting. Similar relationships exist between snatch results and throwing ability. In addition, according to the aforementioned authors, increased flexibility is initially a factor of performance in Olympic weightlifting, but the relationship is J-shaped and after a certain level of flexibility is reached, further improvements have no positive effects on results, and in some cases may even make them worse.

As shown in the figures and tables, the 14-year-old athletes of our study sample dominate in most tests of physical fitness. Although this finding is somewhat unexpected, in our opinion, it corroborates the opinion of other researchers that regular sports-specific training and training age, but not biological age, are the main factors of performance in Olympic weightlifting (Boyanov, Yankova 2009, Yankova, 2016).

Overall, based on our results bring, we can conclude that cadet-weightlifters who regularly participate in organized forms of Olympic weightlifting training demonstrate a high level of physical fitness development. In our opinion, such complexity in

motor abilities is a direct result of regular and purposeful sports-specific preparation. In addition, the parameters we measured are considered particularly important not only for the overall strength development of young people but also for its realization in strength and power sports disciplines.
According to Slavova (2017), regular testing and monitoring in sports is a powerful tool for building systematic informational feedback on control of performance. It helps coaches and athletes to assess their strong and weak abilities and successfully improve performance by manipulating the training program accordingly.

Although not tested for statistical significance of differences between groups, in our opinion, our results can be successfully used as basic prognostic tools for the physical development of young weightlifters. As these parameters of physical fitness combine in complex interdependent networks to form sports-specific skills and abilities, monitoring their temporal dynamics is particularly important for optimizing performance. In addition, regular testing and monitoring of the motor abilities of young Olympic weightlifters can be incorporated into the system of sports selection so that coaches can classify young athletes by genetics and discover the most talented of them. This allows the lagging physical abilities to be treated accordingly by developing specialized and individualized training systems by cohorts based on physical fitness development. This approach can decrease the variability induced by the heterochronicity of motor abilities during growing and maturation and help coaches develop the best possible results for each young athlete.

The results of this study lead to the conclusion that a well-planned and specialized sports-specific training program can successfully develop the most important motor and physical abilities for Olympic weightlifting in young athletes – lower extremity explosive strength, speed, agility, and flexibility. The variability in the results by biological age we found may be due to the periodic lockdowns during the Covid-19 pandemic, which not only disturbed the planned process of regular training but also inevitably transformed the usual active daily regimens of young athletes into more sedentary and weight gain promoting. However, overall, our results demonstrate that proper sports selection and planning of the training process inevitably improve physical fitness in young Olympic weightlifters. In this regard, the tests we used can be incorporated into a program of regular testing and monitoring of physical fitness development of cadet-weightlifters to help coaches build a control feedback mechanism and improve the training process.

REFERENCES

Abadjiev, I., Furnadjiev, V. (1986). *Podgotovka na tejkoatleta,* MiF, Sofia// Абаджиев, И., Фурнаджиев, В. (1986). *Подготовка на тежкоатлета*, МиФ, София
Boyanov, V., Yankova, N. (2009). Sravnitelen analiz i razlishia v individualnata podgotovka na kadetki, devoiki I jeni-tejkoatletki., *Sport i nauka*, izv. br. 2, pp. 19 //Боянов, В., Янкова, Н. (2009). Сравнителен анализ и различия в индивидуалната подготовка на кадетки, девойки и жени-тежкоатлетки., *Спорт и наука*, изв. бр. 2, стр.19.
Dobrev, D. (1983). *Silova, taktic heska i voleva podgotovka na tejkoatleta,* ECNPKFKS // Добрев, П. (1983). *Силова, тактическа и волева подготовка на тежкоатлета,* ЕЦНПКФКС, София
Gurkov, D. (1992). *Tejka atletika v detska i unosheska vazrast*, ECNPKFKS //Гюрков, Д. (1992). *Тежка атлетика в детска и юношеска възраст*, ЕЦНПКФКС
Gurkov, D., Dimitrov, D. (1992). *Tejka atletika v detska i unosheska vazrast*, Sofia //Гюрков, Д., Димитров, Д. (1992). *Тежка атлетика в детска и юношеска възраст*. София.
Panayotov, V. (2018). *Muskuli, Kulturizam, fitness, silova podgotovka,* Sofia //Панайотов, В. (2018). *Мускули Културизъм, фитнес, силова подготовка*, София
Slavova, V. (2017). *Smeseno obuchenie. Principi, podhodi i praktiki*., Izd. Avangard Pres. Sofia // Славова, В. (2017). *Смесено обучение. Принципи, подходи и практики*. Изд. Авангард Прес, София
Soboleva, T. (1997). Formirovanie polozavisimih harakteristik u devochek I devushek na fone zaniatii sportom, Dis. dok. boil. nauk.-SPb., pp. 245// Соболева, Т. (1997). Формирование полозависимых характеристик у девочек и девушек на фоне занятий спортом, Дис. док. биол. наук.-СПб., стр. 245
Zatsiorsky, V. (1970). *Fizicheskie kachestva sportsmen*, Moskva //Зациорский, В. (1970). *Физические качества спортсмена*, Москва,

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TRAINING LOAD BY BIATHLETES AND CROSS-COUNTRY SKIERS IN MACROCYCLE

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ABSTRACT
In this study, it will be considered in detail, analyzed, and compared the plan-programs in the annual macrocycle, of Bulgarian cross-country skiers and biathletes, and more specifically their general and specific indicators. This would give us much clearer direction in planning the training load in each of the two sports and at the same time the opportunity to make timely adjustments to the training process to increase its effectiveness. In accordance with the purpose and tasks thus set, we applied the following traditional research methods: a survey of methodical scientific literature in cross-country skiing and biathlon, comparative content analysis of training plan programs, targeted pedagogical monitoring of the training process, as well as mathematical and statistical methods. The results show that in both programs, a 7-day version of microcycle in the presented total of 12 mesocycles. The total training load for biathletes participating in the World Cup is 903 h. This is in cross-country skiers - 1050 h. The special training is 68% and the general - 32%. For biathletes, 65% is the special work, and 35% is the general work. To achieve higher results in international competitions in both winter sports, it is necessary to increase the total training load in the annual macrocycle. Also, training tools and modes of operation must be updated in terms of the load intensity.

Keywords: *biathlon, cross-country skiing, training load, periodization*

INTRODUCTION

With the growing importance of the World Cup competitions, including without discounting the Olympic Games and the World Championships, in recent years, there has been an additional motivation for biathletes and cross-country skiers, who participate in all World Cup competitions whenever possible, and more than once throughout the whole competitive season show outstanding results.

It is known that the sports calendar can be an essential factor for the effective construction of sports training only on the condition that it is consistent with the general regularities of the adaptation process and, more precisely, with the time intervals (periods, stages, microcycles, etc.) that it provides for reaching and maintaining the sports form (Zhelyazkov et al., 2020). Many elite athletes and their personal trainers carefully select the most important competitions according to their goals and objectives. In systematic training, we consider the annual macrocycle as a series consisting of 52 training weeks, in which each subsequent week is related to the previous one. This series includes 13 four-week cycles (Sleamaker, Browning, 1996).

As the tasks to increase individual capabilities change, there is a need for different options to achieve the highest results during the annual training cycle (Nitzsche, 1998).

Cross-country skiing as a sport requires a high level of training, and stable results in terms of general and special performance, as a basis for achieving maximum sports results. This can only be achieved within the framework of a multi-year targeted preparation. With a certain level of the body's aerobic capacity, level of strength indicators related to more specific motor activity, technical mastery, psychological preparation, etc. (Zografov, 2011).

The main parameters of the physical load for biathletes, as well as for cross-country skiers, are the volume and intensity of the training load, as well as the means used, i.e., its nature. Successful participation in competitions depends exclusively on the correct distribution of the load in terms of volume and intensity in the micro-, meso- and macrocycles (Dunaev, 2007; Bezmeylnitsyn, 2011).

The conducted research testifies that the training program is based on the model-target approach in the periodization of the sports training with parallel development of the "basic" and profiled qualities of the cross-country skiers and biathletes (Matveev, 2000).

From the literature review, we believe that the problem of determining the main indicators of the training load in the annual cycle is relevant, and its research would lead to the improvement of sports results in cross-country skiing and biathlon.

For this purpose, we carried out a comparative analysis of the plans-programs of the training load of the Bulgarian biathlon and cross-country skiers.

In accordance with the objective thus set, the following tasks were defined:

- To compare and analyze the dynamics of the total volume of the training load (by mesocycles) in the annual macrocycle.
- To compare and analyze the training load distribution by training means (general and specific) in the annual macrocycle.
- To determine the optimal ratio of the main parameters of the physical load in the annual macrocycle

METHODS

The *object* of the present research are the training plans-programs of the Bulgarian biathlon and cross-country skiers (men) and the *subject* - their general and specific training indicators.

The purposeful preliminary studies of the specialized literature and practice in the field of biathlon and cross-country skiing provided the basis for formulating the *Thesis* that a thorough study of the indicators of the training load in the annual macrocycle and a comparative analysis of the two plans-programs would give us a significant a clearer direction in planning the training load in each of the two types of sports and at the same time an opportunity to make a timely correction in the training process, to increase its effectiveness.

The *research subjects* are the biathletes and cross-country skiers from the national teams of Bulgaria (men).

The main work carried out during the research was a thorough analysis of the plans-programs of the national biathlon and cross-country teams of the Bulgarian athletes. We compared the training plans-programs in the annual training cycle and specifically their general and specific training indicators and determined the optimal ratio of the main parameters of the training load.

In accordance with the set goal and tasks, we applied the following traditional research *methods*: Study of the scientific and methodological literature, Comparative content analysis of training plans-programs, purposeful pedagogical observation of the training process, as well as mathematical and statistical methods.

RESULTS

The analysis of training plans shows that biathletes and cross-country skiers use the seven-day version of the microcycle most often. Figure 1 presents information on the total load in the mesocycles of biathletes. What is striking is that in mesocycles one (April), two (May), and three (June) of the general preparatory stage, as well as in the fourth (July), fifth (August), seventh (October), and eighth (November) mesocycle of the special preparatory stage, the largest volume of work in terms of hours was carried out. In this way, the basic principles in programming the training process in the annual cycle are respected. Mesocycle number six (September) also sees the smallest load during the macrocycle. The orientation of the load is primarily restorative in nature, which also coincides with the transition period before the next special preparation stage. During mesocycles nine (December), ten (January), eleven (February), and twelve (March), there is a decrease in the total training load, which is related to entering the competition period. The mean value of the standard deviation of the total amount of training hours by mesocycles amounts to 72.5±34 h. The total volume of training load in the annual macrocycle, including strength work for biathletes participating at the highest level in the World Cup, is 903 h.

For cross-country skiers, the first mesocycle begins at the beginning of May. In the diagram shown in Figure 2, it is noticeable that the training load is distributed almost evenly during the preparatory period.

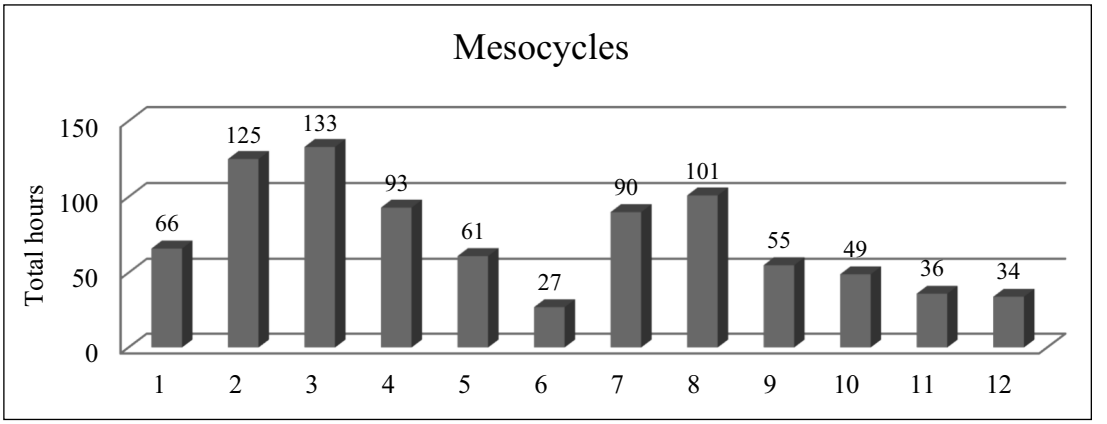

Figure 1. *Dynamics of training load in the annual macrocycle in hours in elite biathletes*

The exception is the seventh mesocycle, where the largest volumetric load was also carried out. With the entry into the competition period, a gradual decrease in the training load is also observed, which indicates an incomplete recovery when participating in the first competitions of the season. During mesocycle twelve, the least training load is also carried out, which coincides with the transition period of the annual macrocycle. The mean value of the standard deviation of the total amount of training hours by mesocycles amounts to 87.5±24.9 h. The total load in the annual macrocycle is 1050 h., which is about 150 h. more compared to the plan-program of biathletes**.**

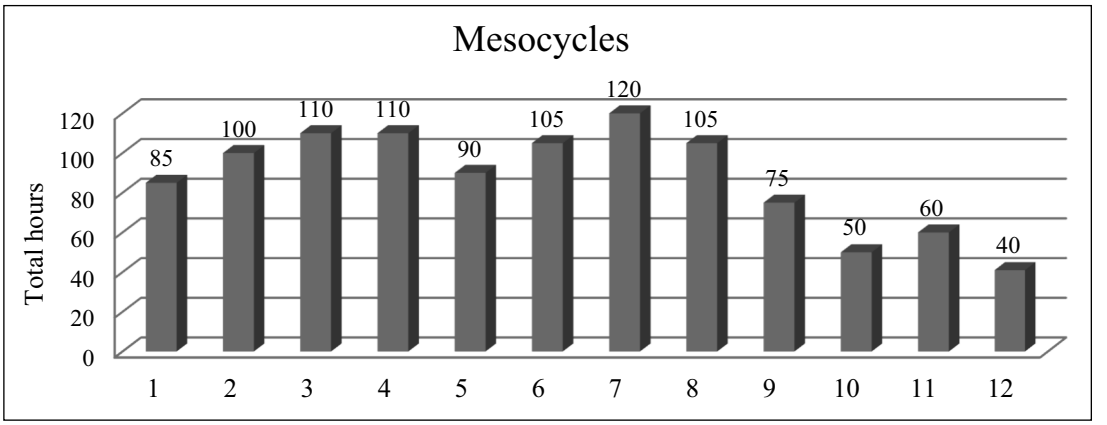

Figure 2. *Dynamics of training load in the annual macrocycle in hours in elite cross-country skiers*

The distribution of the training load by cyclical means in the annual training cycle for biathletes is presented in Figure 3. The running work performed (cross, cross-walk, cross-imitation) constitutes 24% or 124 h. of the total volume of the training load. The lowest volume of work is observed with the bicycle - 11% - 60 h. For roller skis, 27% - 140 h., and for the main means of skis, 38% - 200h.

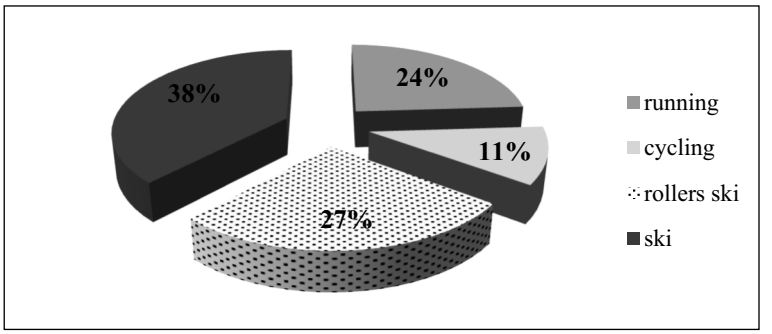

Figure 3. *Ratio of cycle training agents in elite biathletes*

In the distribution of cyclic means in the annual cycle, interesting differences are observed in the values of the training indicators of ski runners, which are presented in Figure 4. For them, the special means - skis, as a percentage of the total load is 10% more - 48% - 540 h., compared to biathletes – 38%. No significant differences were observed in running training and cycling, respectively 27% - 305 h and 5% - 55 h. The ratio of the means of roller skis for cross-country skiers is 20% or 225 h., compared to biathletes, which is 27%. With the special means (roller skis and skis) of the two programs as indicators, the load is presented in total in the two styles of movement – classic and skating style).

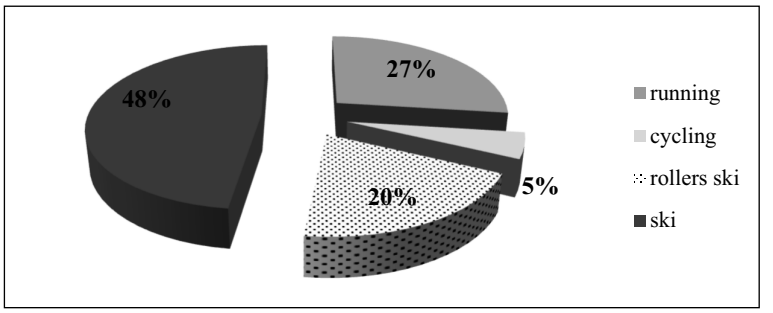

Figure 4. *Ratio of cycle training means in elite cross-country skiers.*

The dynamics of the training load by means, distributed by mesocycles in the annual cycle for biathletes, are shown in Figure 5, and for cross-country skiers in Figure 6.

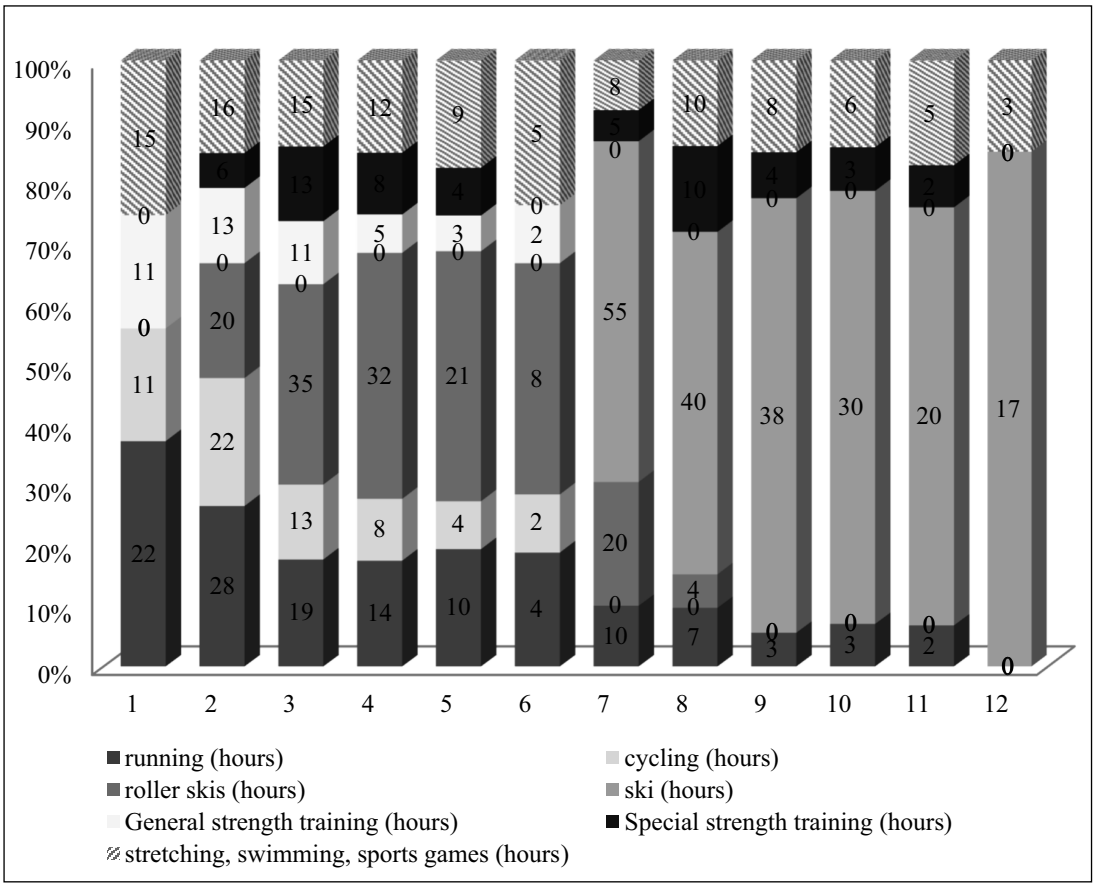

Figure 5. *Distribution of training means by mesocycles in the annual cycle in elite biathletes.*

The presented results show that the running work (cross, cross-walking, cross-imitation) and cycling, both in the biathletes and in the cross-country skiers, were performed in the first five mesocycles of the preparatory period. In contrast, the cross-imitation was concentrated in the fifth and sixth mesocycles

in the biathletes. In cross-country skiers, it covers, in addition to the fifth and sixth, also the fourth mesocycle. In biathletes, roller skis are also distributed in the first five mesocycles, as in cross-country skiers. Still, in them, the largest volume load in the roller ski device is concentrated in the third, fourth, and fifth mesocycles, and in biathletes, a very high volume load is also performed and in the sixth mesocycle.
In the case of biathletes, the special load on the ski equipment is, to the greatest extent, concentrated in the competition period (ninth - twelfth mesocycles), and the bulk work was done during the seventh and eighth mesocycles. In cross-country skiers, a significant difference is observed in the distribution of the special means of skiing compared to biathletes. The load is concentrated both during the competition period and in the special preparation stage of the annual cycle (sixth - twelfth mesocycles), as well as in the first two mesocycles of the general preparation stage. Here, it is of interest that the cross-country skiers planned 10 mesocycles with ski training, while the biathletes planned ski training in only 6.

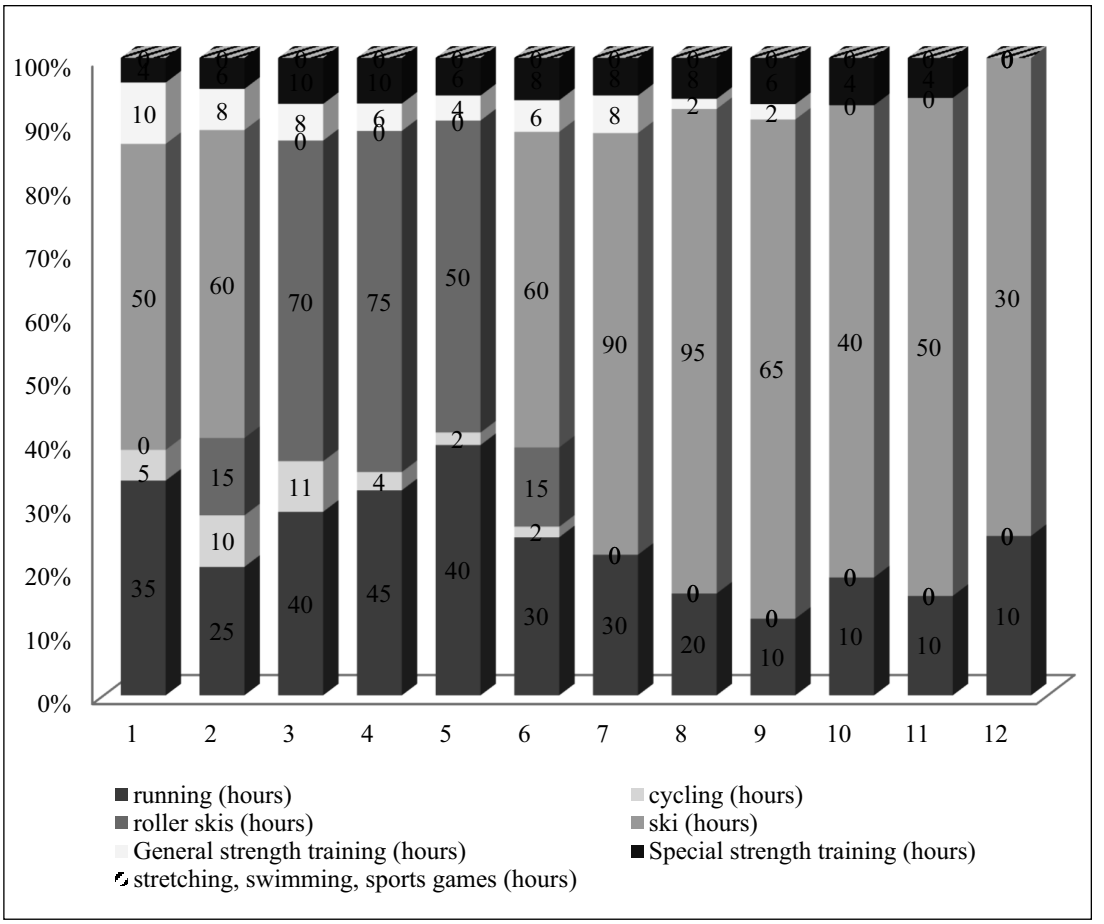

Figure 6. *Distribution of training means by mesocycles in the annual cycle in elite cross-country skiers.*

The stretching, swimming, and sports games prevail throughout the macrocycle, as the only increase in indicators is observed at the beginning of the preparatory period, both for biathletes and cross-country skiers. General strength training is also concentrated during the preparatory period. It is interesting that during the speciall preparatory stage and during the competitive period, strength loading of a general nature is not planned at all in both plans-programs, which in our opinion is inappropriate from a methodological point of view, considering that the strength abilities need to be maintained at a high level during the competition period as well. The load in the Special strength training is distributed almost evenly throughout all mesocycles and in both plan-programs of the annual macrocycle.
Regarding the ratio of work modes, which are presented in Figure 7 and Figure 8, it can be seen that the main training load for biathletes and cross-country skiers was carried out in Zone 2 and Zone 3 of energy supply, respectively 37,% - 195 h. and 31% -

163 h., with cross-country skiers doing 38% of the work in Zone 2, and 14% in Zone 3. In Zone 4, the load is 53 h. – 10% of the total and performed load, and for cross-country skiers it is 12%. The training load in Zone 5 is 2% - 11 h. in both sports. Recovery training in Zone 1 took 20% or 102h in biathletes, while in cross-country skiers, they are 34% of the total load in the annual macrocycle.

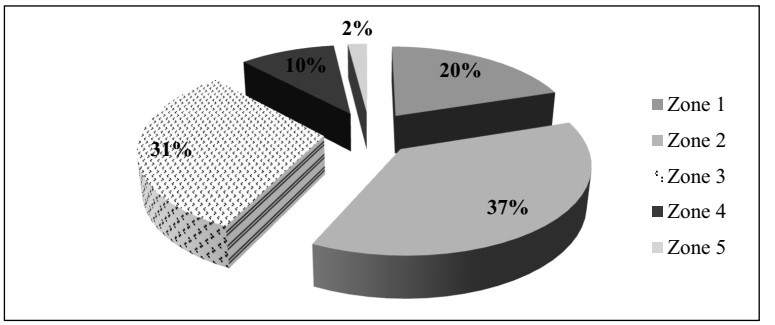

Figure 7. *Correlation of work modes in elite biathletes*

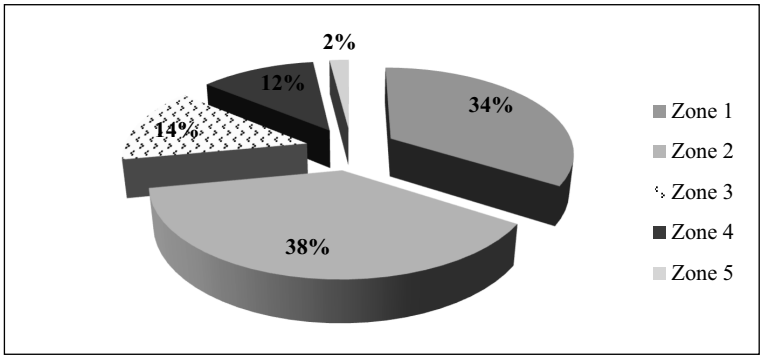

Figure 8. *Correlation of work modes in elite cross-country skiers*

DISCUSSION

Within the given structure of planning the training load in the annual macrocycle, the separate stages and periods of preparation are clearly expressed. From the thus presented structure of biathletes, we can say that the planning is bicyclic. In biathlon, two-cycle planning is preferred when programming the training process in elite biathletes (Palakarski, 2014). We can say from the presented planning structure that a single-cycle periodization was used for the cross-country skiers compared to the biathletes' plan-program. In a practical aspect, when programming the plans, the most important thing is the management of the sports form to achieve the highest sports result in the main start for the year, which in biathlon as well as in cross-country skiing is in the month of February (then mainly World Championships or Olympic Games), and at the same time keeping it at the highest possible level for the remaining competitions until the end of the competition period.

It was already mentioned above that the total training volume for biathletes is 903 h and for cross-country skiers, 1050 h. Special training can reach 65% and more of the total volume. For cross-country skiers, special training is 68%, and general training is 32%. For biathletes, 65% is the special work and the general 35% of the total volume for the macrocycle. At the final stage of preparation, a high share of special training is observed, but the share of general and auxiliary training can also increase, but only within narrow limits (Platonov, 2014). The same author recommends that the maximum realization of individual capabilities in elite athletes should be about 1400 h. annual volume, being distributed as follows: special training – 65%, auxiliary – 23%, and general – 12%. According to this criterion, we can say that both plan-programs meet the requirements for the distribution of the training load.

The comparative analysis of the plan-programs and specifically of the training indicators in the annual macrocycle generally show that both programs meet the regulatory requirements for planning the training load for highly qualified cross-country skiers and biathletes. The distribution of the training load by training means in the annual cycle of sports

training is characterized by a variety of means, wide use of means from different sports, and also different sports games. From the above results and our personal observations, we can determine the optimal ratio of the main parameters (general and special) of the physical load in the annual macrocycle**,** namely, the total load in both types of sports should reach the limits of around 1300 – 1400 h. annual training volume and special training should be in the range of 65% - 68%. To reach the results of the leading nations in these types of winter sports and to achieve higher results, an increase in the total training load in the annual macrocycle is necessary. Also, training equipment and work modes should be updated in terms of load intensity.

REFERENCES

Bezmelynitsyn, N. G. (2011). Iskhodnoe sostoyanie i tendenciya razvitiya biatlona na sovremennom ehtape. Sovremennaya sistema sportivnoj podgotovki v biatlone: materialy *Vserossijskoj nauchnoprakticheskoj konferencii,* Omsk, s. 46-48. // Безмельницьин, Н. Г. (2011). Исходное состояние и тенденция развития биатлона на современном етапе. Современная система спортивной подготовки в биатлоне: материали Всеросийской научнопрактической конференций, Омск, с. 46-48.

Dunaev, K. S. (2007). Proektirovanie dinamiki nagruzki v godichnom tsikle trenirovki kvalifitsirovannyih biatlonistov. *Uchebnyie zapiski universiteta im. P .F. Lesgafta,* No 10 (32). s. 32-34. // Дунаев, К. С. (2007). Проектирование динамики нагрузки в годичном цикле тренировки квалифицированньих биатлонистов. Учебньие записки университета им. П .Ф. Лесгафта, № 10 (32). с. 32-34.

Matveev, L. P. (2000). Modelyno-tselevoy pohod k postroeniyu sportivnoy podgotovki (statya pervaya), *Teoria i praktika fiz. Kulyturы,* No 2, s. 28–31. // Матвеев, Л. П. (2000). Модельно-целевой поход к построению спортивной подготовки (статья первая), Теория *и* практика физ. Культуры, № 2, с. 28–31.

Matveev, L. P. (2000). Modelyno-tselevoy pohod k postroeniyu sportivnoy podgotovki (statya vtoraya), *Teoria praktika fiz. kulyturы,* No 3, s. 28–37. // Матвеев, Л. П. (2000). Модельно-целевой поход к построению спортивной подготовки (статья вторая), Теория практика физ. Культуры, № 3, с. 28–37.

Nitzche, K. (1998). *Biathlon: Leistung – Training – Wettkampf; Ein Lehrbuch fur Trainer, Ubungsleiter und Aktive* / hesg. Von Limpert Verlag Wiesbaden, pp. 358.

Palakarski, G. I. (2014). Disertatsia: *Upravlenie na trenirovachnia protses pri elitni biatlonisti,* s. 132. // Палакарски, Г. И. (2014). Дисертация: Управление на тренировъчния процес при елитни биатлонисти, с. 132.

Sleamaker, R., Browning, R. (1996). *Serious Training for Endurance Athletes.* Human Kinetics, pp. 324.

Zhelyazkov, Ts., Dasheva, D., Neykov, S. (2020). *Osnovi na sportnata trenirovka*, BOLID-INS, Sofia, c. 249. // Желязков, Ц., Дашева, Д., Нейков, С. (2020). Основи на спортната тренировка, БОЛИД-ИНС, София, с. 249.

Zografov, P. (2011). *Osnovi na sportnata trenirovka na elitni skiori begachi*, NSA PRES, Sofia, s. 107. // Зографов, П. (2011). Основи на спортната тренировка на елитни скиори бегачи, НСА ПРЕС, София, с. 107.

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METHODOLOGY FOR IMPROVING THE TECHNICAL SKILLS OF SHOOTING IN BIATHLON

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ABSTRACT
In this study, we are going to find out how to improve the shooting technique of biathletes. Shooting is an important component of biathlon and its impact on the end result of the race is significant. Many authors specify that the main elements of biathlon shooting are: the shooting position, aiming, holding one's breath, and processing the trigger. This article examines some methods of improvement of the shooting elements and the results of their application. The elite athletes from the Bulgarian national biathlon team - (seven women) were studied, as a specialized methodology for the development of accuracy in shooting was developed and applied in the training process. The following scientific methods were used to resolve the tasks of the research: Bibliography analysis of specialized literature on the problems of the research; Testing; Pedagogical observation. Statistical methods: Variational analysis, the mean and standard deviation were calculated; Percentage analysis. The results show that the overall success rate of the two shooting positions - prone and standing, in all subjects has increased, after the application of exercises to develop shooting abilities, in particular accuracy. Most of the athletes have a high hit rate. Mean ± SD: 86,9 ± 7,3 % for the first test and 92,4 % ± 7,6 % for the second test, which signifies very good shooting skills. In biathlon, the success rate of the shooting is more important, but the higher number of points speaks of better shooting results, respectively for better preconditions to achieve a high success rate in the competitions.

Keywords: *biathlon, technical shooting, shooting elements*

INTRODUCTION

Accuracy of shooting depends on the correct performance of the following elements: taking a position for shooting, aiming, holding one's breath, and processing the trigger, all of these elements are strictly coordinated and closely interrelated (Gelymut, 2000).

The main objective for biathletes is to perform faultless shooting in a short-term period in the conditions of great psycho-physical effort. After that, the laws of ballistics set in, and they cannot be directly influenced by biathletes. According to (Nitzsche et al.,1998), the performance of technical elements, such as: taking a shooting position, aiming, breathing and processing the trigger, and their coordination, should guarantee that during aiming and shooting the weapon is at rest.

Elite biathletes use a lot of options in taking a shooting position. „Adapting the optimal sequence of motor activities for a shooting position to their personal preference, biathletes' major aim should be to achieve speed, avoiding any parasitic, incorrect movements and mastering the complex of actions to perfection – to the point of automatic reactions." (Palakarski, 2016).

According to (Zubrilov, 2013), there are "two schools" in biathlon practice, totally different with reference to shooting position. One is known as the "universally accepted international" school and the other - as the "Scandinavian" school. In some older Soviet Union literary sources, it is also named the "Estonian" school. And according to some American authors, it is referred to as the "international Olympic" (Pullum, 1973).

Since shooting accuracy is closely connected to the degree of immobility of the weapon, serious attention should be paid to the choice of the most appropriate shooting position, which provides greatest stability and immobility of the system "shooter - weapon" (Yuryev, 1973).

According to (Zubrilov, 2013), the biathlete's body is viewed as a "mount" (basis, foundation), on which the weapon is fixed. That kind of „mount" ought to provide: on the one hand, stability of the weapon for aiming, on the other – unvaried performance of the shot, as far as that performance strongly depends on the initial trajectory of movement of the shot, and consequently, on the deviation of shots from the target, i.e. biathletes need to be as one with their weapon, to have an even and strong grip of it, to keep it immobile at the moment of shooting, and the "kick" should not cause erratic motion of the weapon.

The author (Lonsdeyl, 2008) describes the basic elements of the correct shooting position including three components: the hardness of the human bone structure, muscle relaxation, and a natural point of

aiming. In his opinion, a shooter cannot shoot at a fast pace, due to the repeated kicks of the weapon in a relaxed position, and consequently to realize his/her shooting skills efficiently.
In compliance with the competition rules of IBU, in biathlon, there are two shooting positions: *prone* and *standing.*

When shooting from a prone position, some authors (Dunaev, Savitskiy, 2004) consider that it is necessary to ensure the stability of the weapon at the least muscle strain and natural head position, providing optimum position for the eyes during aiming.

The Russian specialist in sport shooting (Yuryev, 1973) notes that the prone shooting position ought to give: an appropriate degree of stability of the system "shooter – weapon" at the least strain of the shooter's motor apparatus; most appropriate conditions for functioning of the senses – the sight and balance (vestibular apparatus) in the first place; good conditions for the normal functioning of internal organs and blood circulation.
Shooting from a standing position is relatively more difficult than shooting from a prone position. According to some authors (Zubrilov, 2013; Yuryev, 1973), this is due to the more unstable position – the higher center of gravity of the system "shooter – weapon". The support surface is smaller in comparison to that in a prone position, and as a result, the projection of the total center of gravity is moved to the edge of the support surface; also the "cushioning" effect of the skis creates instability of the position; the cinematic chain involved in holding the weapon (already activated by a greater amount of bio-elements).

In biathlon, as in sport shooting, it is not necessary to hit the center of the target, it is important that the hits are within the target circle. Because of the high pulse rate and fatigue, biathletes use a technique in which preparation for the shot starts in the direction of the target but out of the target scope, and on the appearance of the target in the optical sight they process the trigger and shoot. According to (Hoffman et al., 1992) high pulse rate has a greater impact on the accuracy, precision, and stability of the shot from a standing position than from a prone position.
Aiming is a complex process controlled by the sight and motor apparatus, in which the right positioning of optical sight and foresight in line with the center of the target is a major condition for correct aiming. (Gorovoy, 2007; Kinl, 1987; Potapov, 2005; Yuryev, 1962).

The entire complex of actions of the shooter connected with aiming is logically viewed as a complex system of actions including a number of micro-actions with their corresponding micro-tasks, related to taking an appropriate shooting position, holding one's breath, adjusting the optical sight and foresight in line with the target point, directing and keeping the weapon on target (Korha, 1987).

The biathlete's breathing predetermines not only the result of every shot but the entire shooting performance. Before the shooting biathletes have an intensive physical activity, as a result of which, breathing frequency increases to about 50 cycles per minute. The breathing cycle decreases at the expense of shortening the periods of inhalation and exhalation and the complete absence of breathing pause. With biathletes the pause in breathing to produce a shot has to be created artificially. That is necessary, in order to adjust the aiming and process the trigger (Kinly, 1987). There are only two options of holding one's breath in biathlon – performing the shot during incomplete inhalation or during incomplete exhalation.

One of the conclusive and most complicated elements of the shooting technique is the processing of the trigger. The technique of processing the trigger depends on the quality of adjustment of the trigger mechanism. J. Cooper, one of the most respected specialists in sport shooting, notes that the art of shooting depends mostly on the trigger, and it is better to have an inaccurate weapon with a well-adjusted trigger mechanism than the other way round (Kuper, 2000).

The leading skills and the quality of processing the trigger, according to a number of specialists in sport shooting and biathlon (Bozerzhan, 2006; Vaynshteyn, 1960; Korha, 1987; Yuryev, 1962; Nitzsche, 1998) are – arbitrariness, smoothness, confidence and control. In order to produce a shot, a biathlete should process the trigger smoothly, without movement of the weapon. However, the achievement of absolute immobility while performing the shot is a very hard task, processing the trigger is done with a bigger or smaller quiver of the weapon. That is why processing the trigger should be performed not only smoothly, but in strict coordination with

aiming and breathing.

From the analysis of various approaches and ways of realization of all elements of the shooting technique (shooting position, aiming, holding one's breath, and processing the trigger), it is obvious that without correct performance and coordination between the elements, no high results could be expected with reference to the quality of shooting.
For the performance of accurate shooting in the conditions of inevitable psycho-physical strain in biathlon, it is necessary to create conditions for modeling that kind of environment in the training process.

The main *objective* of the research is to create exercises for improvement of the separate technical elements, and for their synchronization. For the achievement of our goal, the following *tasks* were set:

- To study the theoretical and methodological literature on the problem in order to analyze the contemporary views on the accuracy of shooting.
- To select and approve a set of exercises for the improvement of accuracy in shooting.
- To check the effectiveness of the set of exercises for improvement of the performance of technical elements in shooting with biathletes.

METHODS

Hypothesis: It is presumed that the application of means and methods aimed at mastering and perfecting the technical elements in shooting, as well as their synchronization in the process of training, will have a positive influence on the improvement of the quality of shooting with biathletes.

Subjects of the research

The subjects of the research were seven women's from the Bulgarian national team in biathlon. A specialized methodology for the development of shooting accuracy was created and applied in the training process. In the course of one mezzo-cycle of 14 days, two tests for shooting accuracy were organized (recording every shot). A preliminary test was held at the beginning of the experiment to determine the initial level of accuracy of the competitors and a control test – at the end of the mezzo-cycle.

The training process included the performance of exercises for:

- the development of basic shooting training – dry shooting (BST-1) and BST-2;
- the improvement and stable performance of the technical elements;
- coordination of the shooting elements to the point of automatic reactions;
- stabilizing the automatic reactions;
- improving psychological qualities, such as the ability to increase concentration (by shooting at: - figures and targets with different diameters) and the ability to keep concentration, self-confidence, and sport workability;

Research methods

The following scientific methods were used to resolve the tasks of the research:

- Bibliography analysis of specialized literature on the problems of the research;
- Testing;
- Pedagogical observation;
- Variational analysis – the mean and standard deviation were calculated;
- Percentage analysis;

RESULTS

The results on the basis of gained points and missed targets in the test (30 shots from prone position and 30 shots from standing position) are presented in (Table 1). As it can be seen from the acquired results in the table, there is an increase in the achievements of all subjects of the research after the application of the specialized set of exercises. The only exception is noted with competitor № 2. Her results from the preliminary test in the prone position (263 points) are better than those in the control test (251 points), her missed shots are also a bigger number. However, from a standing position, the results of the same competitor in the control test are better (166 points) than in the preliminary test (126 points), and the mistakes are also fewer - 7 against 13 missed shots. From the total number of points, it is obvious that the points gained in the control test are more than those in the preliminary, and respectively, the missed shots are fewer. The phenomenon observed with competitor № 2 could be explained by the fact, that there was a correction in her prone position, and the adaptation time with this new position for the competitor was prolonged. Another peculiarity was observed in the results from the standing position of competitor № 6. In the preliminary test, she had no missed shots and achieved a result of 205 points. In the control test, she had 3 missed shots but gained a greater number of points – 210.

Table 1. *Test 30 shots in prone position and 30 shots in a standing position (P – points; M – mistake)*

Competitor	Test	3 series of 10 shots – prone position							3 series of 10 shots – standing position							Total Punishments	Total Points
		P	M	P	M	P	M	Prone	P	M	P	M	P	M	Standing		
1	1	86	1	83	3	92	0	**4 –261**	66	0	65	0	62	1	**1 - 193**	**5**	**454**
	2	97	0	96	0	93	0	**0 - 286**	75	0	74	0	73	1	**1 - 222**	**1**	**508**
2	1	81	2	93	1	89	0	**3 - 263**	34	5	36	6	56	2	**13 -126**	**16**	**389**
	2	81	4	84	2	86	2	**6 - 251**	54	2	51	3	61	2	**7 - 166**	**15**	**417**
3	1	93	0	91	0	82	1	**1 - 266**	65	0	68	1	59	2	**3 - 192**	**4**	**458**
	2	93	0	89	0	89	0	**0 - 271**	63	2	72	0	65	0	**2 - 200**	**2**	**471**
4	1	89	1	88	0	84	2	**3 - 261**	55	2	32	6	62	1	**9 - 149**	**12**	**410**
	2	90	0	88	1	89	0	**1 - 267**	58	1	71	0	46	2	**3 - 175**	**4**	**442**
5	1	88	1	89	2	92	0	**3 - 269**	52	2	58	2	51	2	**6 - 161**	**9**	**430**
	2	92	0	89	2	90	0	**2 - 271**	51	2	71	1	57	1	**4 - 179**	**6**	**450**
6	1	84	3	90	2	88	1	**6 - 262**	62	0	79	0	64	0	**0 - 205**	**6**	**467**
	2	90	0	88	0	90	0	**0 - 268**	67	2	63	1	80	0	**3 - 210**	**3**	**478**
7	1	90	1	93	0	92	0	**1 - 275**	69	1	79	0	71	1	**2 - 210**	**3**	**485**
	2	91	0	93	0	95	0	**0 - 279**	71	1	78	0	73	0	**1 - 222**	**1**	**501**

The biathletes' results on the percentage of hits on target, from the test - 30 shots in a prone position and 30 shots in standing position, are presented in Figure 1.

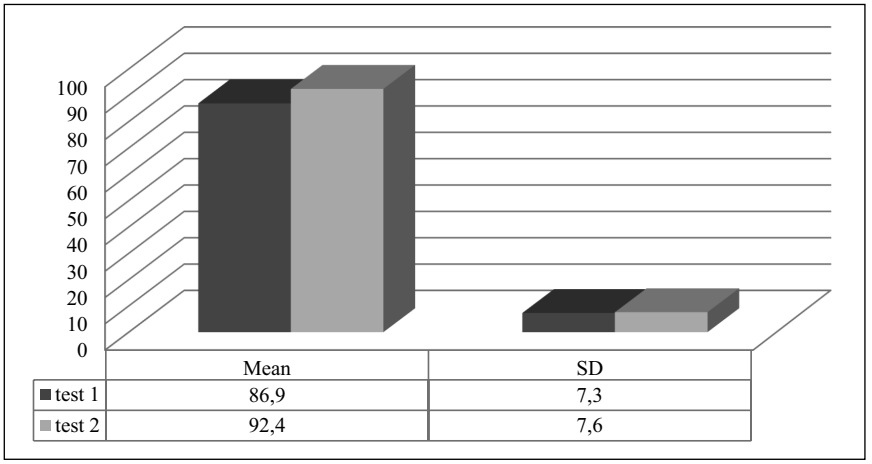

Figure 1. *Percentage of hits on target*

As it can be observed from Figure 1, the total percentage of hits on target from the two shooting positions – prone and standing, was increased with all subjects of the research after the application of the exercises for improvement of the biathletes' shooting skills, accuracy in particular. The greater number of competitors have improved the percentage of hits. The mean standard deviation is 86,9 ± 7,3 % for the first test and 92,4 % ± 7,6 % for the second test, which signifies very good shooting skills.

DISCUSSION

The analysis of the research results shows us that the specialized exercises applied in the training process, aiming at perfecting the technical elements, can help to upgrade the quality of shooting in biathlon. In the standing position, there are more mistakes committed, and a smaller number of points gained, in comparison to the prone position. That is due to the higher center of gravity of the weapon from standing position. In biathlon the percentage of hits is more important, but the greater number of points signifies better shooting skills, consequently, better chances for a higher percentage of hits on target in competitions. From the acquired results our hypothesis was also confirmed, i.e. the application of purposeful specialized training means and methods for increasing the shooting accuracy, with reference to improvement and synchronization of shooting technical skills, will lead to better results in competitions. In biathlon competitions, results of 90-96 % hits are considered as a very high level of shooting skills.

The analysis of the scientific-methodological literature and the summary of the practical experience

showed that in the process of developing the methodology of shooting training of biathletes there are not targeted and specialized tools and methods for preparation of shooting training. For that reason, was developed, implemented and proven a methodology to improve the quality of shooting for biathletes. On the basis of the acquired results, it is necessary to introduce specialized exercises in the training process for all age groups of the Bulgarian national team in biathlon (men, women, junior men and junior women). In this way the technical skills of the biathletes will be improved.

REFERENCES

Bozerzhan, Zh. (2006). *Spravochnik po sportivnoy strelybe*, Feniks, Rostov, s. 192 // Бозержан, Ж. (2006). Справочник по спортивной стрельбе, Феникс, Ростов, с. 192.

Dunaev, K. S., Savitskiy, Ya. I. (2004). Zavisimosty sportivno-tehnicheskogo rezulytata ot skorosti bega i metkosti strelybы v biatlone, *Teoria i praktika fizicheskoy kulyturы,* № 12, s. 43-46. // Дунаев, К. С., Савицкий, Я. И. (2004). Зависимость спортивно-технического результата от скорости бега и меткости стрельбы в биатлоне, Теория и практика физической культуры, № 12, с. 43-46.

Gelymut, V. Ya. (2000). *Optimizatsia trenirovochnogo protsessa kvalifitsirovannыh biatlonistov na osnove formirovania spetsialynoy podgotovlennosti v godichnom tsikle trenirovki:* Avtoreferat, Disertatsia, Omsk, s. 17. // Гельмут, В. Я. (2000). Оптимизация тренировочного процесса квалифицированных биатлонистов на основе формирования специальной подготовленности в годичном цикле тренировки: Автореферат, Дисертация, Омск, с. 17.

Gorovoy, S. A. (2007). *Fizicheskie osnovы funktsionirovania strelkovo-pushechnogo, artilleriyskogo i raketnogo oruzhia*. Ballistika, ucheb. posobie, SGGA, Novosibirsk, s. 140. // Горовой, С. А. (2007). Физические основы функционирования стрелково-пушечного, артиллерийского *и* ракетного оружия. Баллистика, учеб. пособие, СГГА, Новосибирск, с. 140.

Hoffman, M. D., Gilson, P. M., Westenburg, T. M., Spencer, W. A. (1992). Biathlon shooting performance after exercise of different intensities, *International Journal of Sports Medicine*, Vol. 13, Issue 3. pp. 270-273.

Kinly, V. A. (1987). *Biatlon*, Zdorov'ya, Kiev, s. 215. // Кинль, В. А. (1987). Биатлон, Здоров'я, Киев, с. 215.

Korha, A. Ya. (1987). *Sportivnaya strelyba*, Fizkulyturya i sport, Moskva, s. 255. // Корха, А. Я. (1987). Спортивная стрельба, Физкультурьа и спорт, Москва, с. 255.

Kuper, D. (2000). Iskusstvo vintovki, *Ruzhye*, № 1,3,6. // Купер, Д. (2000). Искусство винтовки, Ружье, № 1,3,6.

Lonsdeyl, M. V. (2008). Osnovyi metkoy strelybyi snaypera, available at: https://sites.google.com/site/sniperinvisiblewarrior/trenirovki/osnovy-metkoj-strelby-snajpera-mark-v-lonsdejl, (accessed 21 September 2022). // Лонсдейл, М. В. (2008). Основьи меткой стрельбьи снайпера, available at: https://sites.google.com/site/sniperinvisiblewarrior/trenirovki/osnovy-metkoj-strelby-snajpera-mark-v-lonsdejl, (accessed 21 September 2022).

Nitzsche, K. (1998). *Biathlon, Leistung – Training – Wettkampf*, Ein Lehrbuch fur Trainer, Ubungsleiter und Aktive, Von Limpert Verlag Wiesbaden, pp. 358.

Palakarski, G. I. (2016). *Biatlon, Strelkova podgotovka* – monografia, Izd. NSA PRES, Sofia, s. 122. // Палакарски, Г. И. (2016). Биатлон, Стрелкова подготовка – монография, Изд. НСА ПРЕС, София, с. 122.

Potapov, A. A. (2005). *Iskusstvo snaypera*, Fair-Press, Moskva. s. 404. // Потапов, А. А. (2005). Искусство снайпера, Фаир-Пресс, Москва. с. 404.

Pullum, W. C. (1973). *Position rifle shooting: a how-to text for shooters and coaches,* Winchester Press, New York, pp. 272.

Vaynshteyn, L. M. (1960). *Osnovyy strelkovogo masterstva*, DOSAAF, Moskva, s. 232. // Вайнштейн, Л. М. (1960). Основьй стрелкового мастерства, ДОСААФ, Москва, с. 232.

Yuryev, A. A. (1962). *Sportivnaya strelyba*, Fizkulytura i sport, Moskva, s. 383. // Юрьев, А. А. (1962). Спортивная стрельба, Физкультура и спорт, Москва, с. 383.

Yuryev, A. A. (1973). *Pulevaya sportivnaya strelyba*, Izd. 3-e, pererab. i dop., „Fizkulytura i sport", Moskva, s. 432. // Юрьев, А. А. (1973). Пулевая спортивная стрельба, Изд. 3-е, перераб. и доп., „Физкультура и спорт", Москва, с. 432.

Zubrilov, R. A. (2013). *Stanovlenie, razvitie i sovershenstvovanie tehniki strelybyi v biatlone:* monografia, 2-e izdanie, dopolnonnoe i pererabotannoe, Sovetskiy sport, Moskva, s. 350. // Зубрилов, Р. А. (2013). Становление, развитие *и* совершенствование техники стрельбьи *в* биатлоне: монография, 2-е издание, дополнонное и переработанное, Советский спорт, Москва, с. 350.

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A COMPARATIVE ANALYSIS OF THE TECHNIQUES USED IN A TAEKWONDO COMPETITIONS BETWEEN 2009-2019

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ABSTRACT
Practiced by millions of people around the world, taekwondo has quickly become a popular sport due to its technical innovation and spectacularity. The goal is to objectify the refereeing and make taekwondo even more attractive to the general public. Comparing technical performance in competitions spanning a decade would shed more light on the specific endurance needed by the modern taekwondo fighter.
The aim of our study was to determine how the technical (quantitative and qualitative) indicators in competition have changed for the elite taekwondo athlete since the introduction of the electronic scoring system in 2009.
The video analysis we performed on Sofia Grand Prix 2019 enabled us to compare the data with previously reported such from 2009. We discovered that the types of kicks used by the competitors amounted to 13 (2009) and 28 (2019). The variation analysis we performed showed that the average strikes per match were 76 (2009) and 193 (2019) with an average per round amounting at 25.33 (2009) and 64.33 (2019). The matches with the most kicks 121 (2009) 208 (2019) were compared, as well as those with the least hits 40 (2009) and 108 (2019). In 2009, the competitors performed a kick every 4.73 seconds, while in 2019 every 1.86 seconds. Based on our findings we concluded that the number of kicks in a taekwondo match has increased twofold compared to 10 years ago, which means that the requirements for speed and strength endurance are even greater. Although the introduction of the electronic scoring system in taekwondo has led to a significant increment in the number and types of techniques in the taekwondo match, the technical indicators of the winners demonstrate that it is not necessary for the athlete to master the whole set of kicking techniques. It is enough to know 3 to 4 kicking techniques but to apply them successfully.

Keywords*: taekwondo, analysis, kicking, sparring, competition*

INTRODUCTION

Taekwondo is the most dynamically developing sport in the Olympic family. Practiced by millions of people all over the planet, Taekwondo has quickly become a popular sport thanks to technical innovations. Their goal is simple – objectification of judging, making taekwondo even more appealing to the general public and the media. All these directions and changes that taekwondo has undergone in the last decade have led to even greater demands on athletes and coaches in terms of training methodology.
The top successful taekwondo player are the ones winning in the various categories of the Olympic Games, World and Continental Championships, as well as the „Grand Prix" and „Grand slam" series. Measuring their technical performance during the match would shed more light on their specific endurance and their playing pattern and would provide useful guidelines for optimizing training methodology.

Aim and objectives of the study

This study aimed to analyze the technical indicators of modern taekwondo competitors and compare them with previous ones.
Due to improved and new electronic systems, as well as constant rule changes, competitors began to look for new techniques to score points. Most of these kicks were hardly used until now, but after the competition rules changed, some of them became even primary. A typical example in this regard is yop chagi - a kick that was not scored by the judges in the past but which has now become one of the main kicks in competitive taekwondo, and the way of fighting in a match has radically changed.
Kicks that in the absence of the PSS, would have not been scored by the judges are now becoming a must-have weapon in the arsenal of any successful Taekwondo competitor.

METHODS

We performed a video analysis based on video recordings of 26 matches in the -49 kg category from the Taekwondo Grand Prix Sofia 2019. We used SPSS, version 23.0 for Windows (IBM corp.Inc, Chicago, IL, USA, 2015) to statistically establish the average number and types of kicks and strikes used in the 49 kg female category matches. Minimum and maximum values were also identified. Kicks that athletes preferred kicks were identified and the point efficiency was calculated for the competitors of the division, which provided a basis for deriving a coefficient of useful action for the entire category. A coefficient of intensity of kicking in each round was also established.
These results were compared to previous data from

the 2009 World Taekwondo Championships.

A modified protocol form of (Avramov, Analiz na svetovnoto parvenstvo po taekuondo 2009, 2010) was used, in which we recorded the type and number of hits in a given bout for each competitor, in which round the hit was made, with which leg or arm the hit was made, how many points it scored, as well as the number and the type of penalties received.

It was necessary to improve the existing protocol sheet for recording the technical indicators in the Taekwondo meeting, due to the lack of techniques in the previous one, as well as the lack of separation of left and right foot strikes.

RESULTS

„Classification is the grouping and arrangement based on similarities" (Andreev, 2010). On the basis of the natural classifications, which according to (Andonov, 2004) are "more complex, but more scientific", lies the most underlying feature, which sufficiently reflects the main features of the classified objects. Kim (1986) classifies the taekwondo techniques to offensive and defensive. According to the rules of the World Taekwondo (2022), different kicks strikes score differently. Of course, for a thorough technical analysis it is required to establish the type of kick and its success.

Table 1. *Main technical indicators in the taekwondo matches of the Sofia Grand Prix 2019*

TYPE OF KICK	NUMBER OF KICKS	NUMBER OF SCORED KICKS	NUMBER OF POINTS FROM THE KICK	AVERAGE NUMBER OF KICKS PER MATCH	COEFFICIENT OF SUCCESS OF THE KICK	% OF THE TOTAL AMOUNT	POINT EFFICIENCY OF THE KICK/ PUNCH
Dollyo chagi	362	15	30	13.92	4.14	87.44	8.29
Front Dollyo chagi	1340	32	62	51.54	2.39	323.67	4.63
Dollyo chagi olgul	27	5	15	1.04	18.52	6.52	55.56
Front Dollyo chagi olgul	191	21	63	7.35	10.99	46.14	32.98
Front Yop chagi	1889	43	86	72.65	2.28	456.28	4.55
Mirro chagi	4	0	0	0.15	0.00	0.97	0.00
Neryo chaggi	12	0	0	0.46	0.00	2.90	0.00
Neryo chaggi	2	0	0	0.08	0.00	0.48	0.00
Bakkuro Neryo chaggi	0	0	0	0.00	N/A	0.00	N/A
Front Neryo chaggi	176	13	191	6.77	7.39	42.51	108.52
Parrumbal Neryo chaggi	3	0	0	0.12	0.00	0.72	0.00
Parumbal dollyo chagi	6	0	0	0.23	0.00	1.45	0.00
Parumbal dollyo chagi olgul	3	0	0	0.12	0.00	0.72	0.00
Dit chaggi	62	5	20	2.38	8.06	14.98	32.26
Dit chaggi olgul	0	0	0	0.00	N/A	0.00	N/A
Tiurige	6	0	0	0.23	0.00	1.45	0.00
Tiurige momtong	11	0	0	0.42	0.00	2.66	0.00
Narrabam dollyo chaggi	0	0	0	0.00	N/A	0.00	N/A
Narrabam dollyo chaggi olgul	0	0	0	0.00	N/A	0.00	N/A
Narre chaggi	1	0	0	0.04	0.00	0.24	0.00
Front nakka chaggi olgul	12	0	0	0.46	0.00	2.90	0.00
Front nakka chaggi momtong	62	7	15	2.38	11.29	14.98	24.19
Rear Nakka chaggi	0	0	0	0.00	N/A	0.00	N/A
Bituro chaggi	2	1	3	0.08	50.00	0.48	150.00
Chirugi	342	121	113	13.15	35.38	82.61	33.04
Clinch Dollyo chaggi	361	68	136	13.88	18.84	87.20	37.67
Clinch Neryo chaggi	149	24	72	5.73	16.11	35.99	48.32
Clinch Dit chaggi	0	0	0	0.00	N/A	0.00	N/A
	NUMBER OF KICKS	**SCORED KICKS**	**POINTS**				
TOTAL	**5023**	**355**	**806**				
TOTAL PER MATCH	**193**	**13.65**	**31**				

Avramov (2009, 2010) published a study of the male -74 kg category from the 2009 World championships in Denmark. Although for the opposite sex, the comparison with our study is curious.

Table 2. *Main technical indicators in the taekwondo matches of the -74 kg of 2009 World Championships, (Avramov, 2012)*

TYPE OF KICK	NUMBER OF KICKS	NUMBER OF SCORED KICKS	AVERAGE NUMBER OF KICKS PER MATCH	NUMBER OF POINTS FROM THE KICK	COEFFICIENT OF SUCCESS OF THE KICK	% OF THE TOTAL AMOUNT	POINT EFFICIENCY OF THE KICK/ PUNCH
Dollyo chagi	1451	112	32.98	112	7.718815	43	7.718815
Front Dollyo chagi	329	25	7.48	25	7.598784	10	7.598784
Neryo chaggi	301	30	6.84	86	9.966777	9	28.57143
Parumbal dollyo chagi	284	7	6.45	7	2.464789	8	2.464789
Narre chaggi	283	29	6.43	34	10.24735	8	12.01413
Chirugi	169	7	3.84	7	4.142012	5	4.142012
Mirro chagi	163	0	3.70	0	0	5	0
Dit chaggi	137	8	3.11	15	5.839416	4	10.94891
Tiurige	70	6	1.59	18	8.571429	2	25.71429
Dollyo chagi olgul	64	9	1.45	27	14.0625	2	42.1875
Parumbal dollyo chagi olgul	42	5	0.95	15	11.90476	1	35.71429
Front Dollyo chagi olgul	31	6	0.70	18	19.35484	1	58.06452
Narrabam dollyo chaggi	22	0	0.50	0	0	0.7	0
	NUMBER OF KICKS	**SCORED KICKS**	**POINTS**				
TOTAL	**3346**	**244**	**364**				
TOTAL PER MATCH	**76.05**	**5.55**	**8.27**				

From the data we have analyzed we can assume it is very likely that every kick we compare between 2009 and 2019 that in 2019 there will be 3 times as many kicks of a given type more. But this is not so. The most striking difference occurs when kicking yop chagi with the front foot. This is the most used kick in 2019 by women. It is also probably the most frequently used kick by men as of 2019. However, 10 years earlier, this kick was not used once in the matches of the World Championships. In 2019, this kick was used 1,889 times in 22 matches at the Sofia Grand Prix in the women's -49 kg division, making an average of 72.6 times per match. In 2009, the number was zero. Of course, this is not a non-existent kick in taekwondo in 2009, but this kick is practically non-existent in sparring since that time, because no matter how hard it is thrown, the judges did not score it. Because the electronic scoring system was introduced quickly, teams did not have time to adapt to it in advance, which led to a style of play at the 2009 World Championships that was also characteristic of matches without an electronic scoring system. Part of this may also be due to the fact that it is a main kick in North Korean Taekwondo, and perhaps out of a desire to avoid similarities between the two, the judges had a directive not to score it, thus limiting its use. Obviously, however, this kick is effective, and after removing the subjective factor of the judges, the technique and tactics in Olympic Taekwondo take the path of natural evolution. In terms of the most commonly used kick in 2009 - the rear leg dollyo chagi, it was used 13.9

times on average per match. In 2019, the same kick was used 32.9 times per match. It should be taken into account that in the present study, the rear leg dollyo chagi from the clinch was calculated separately, due to the specificity of the kick and the practical direction of such data. Otherwise, its use in 2019 will rise to 27 per match. However, in this case, it ranks third in terms of usage. Front-leg dollyo chagi ranks second, which in 2019 was used an average of 51.5 times per match, while in 2009 this kick was used just 7.4 times per match. The advantage of using the front leg in modern Taekwondo is obvious. Whether this is good or bad is irrelevant to a competitor who wants to win his matches. Circumstances require a shift in the training methodology of winning shots. In terms of the number of points realized with a given shot on average per match, in 2009 the leader in the ranking according to this indicator was Dollyo Chagi with a rear leg - 2.54 points. As we noted above, it is also the most frequently used kick at the time. Of course, it sounds logical that the most frequently used kick should bring the most points in an average match. It is its efficacy that necessitates its wide use in Taekwondo matches. In 2019, however, contrary to expectations, the most frequently used kick yop chagi with the front leg, scores an average of 3.3 points and ranks 4th in this indicator. Front leg Neryo Chagi, which averages 7.34 points per game. He was used an average of 6.7 times per Taekwondo match. The same kick, but executed with the back foot, in the same competition, did not bring any points. The same rear leg kick in 2009 was used an average of 6.7 times per match and scored an average of 0.77 points, while the front leg Neyro chagi was not used once in 2009. Punching, or was used in 2009 on an average of 3.8 times per match, scoring an average of 0.16 points per match. In 2019, it was used 13.15 times scoring an average of 4.34 points per Taekwondo match. It should be noted that this is also the only attacking technique that is still scored by judges without its power being measured by an electronic scoring system. The evolution in the punches used over the last 10 years in Taekwondo is a fact.

The average number of points scored for men in 2009 in one match was 5.5 points, while for women in 2019 it was 13.6 points. Again, the difference here is large and we have to consider the advantages of electronic equipment over these of the referee's evaluation of kicks.

Undoubtedly, these changes, whether they make taekwondo attractive to the general public or not, should be taken into consideration by coaches and competitors. Undoubtedly, with the present development, we prove that the intensity, and hence the requirements for the taekwondo player's endurance, have increased significantly.

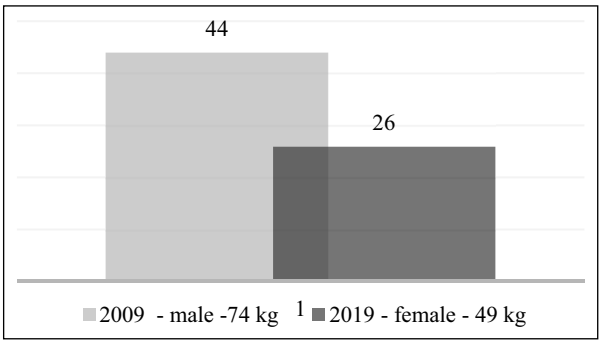

Figure 1. *Number of analyzed matches*

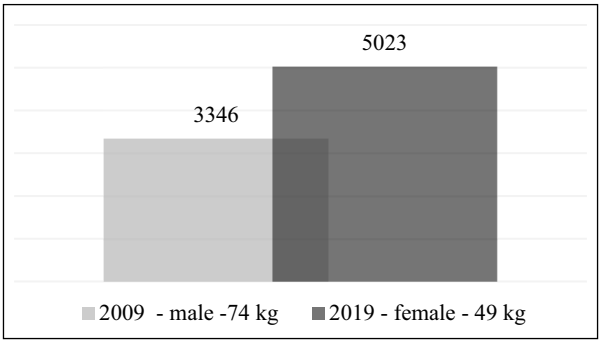

Figure 2. *Number of kicks per category*

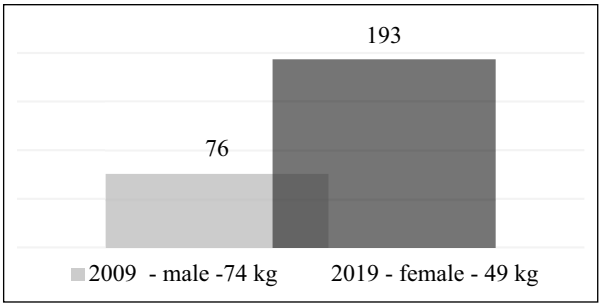

Figure 3. *Average number of kicks per match*

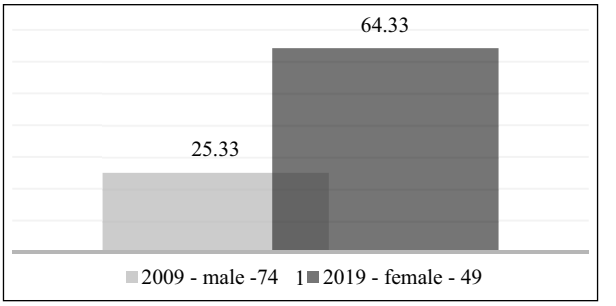

Figure 4. *Average number of kicks per round*

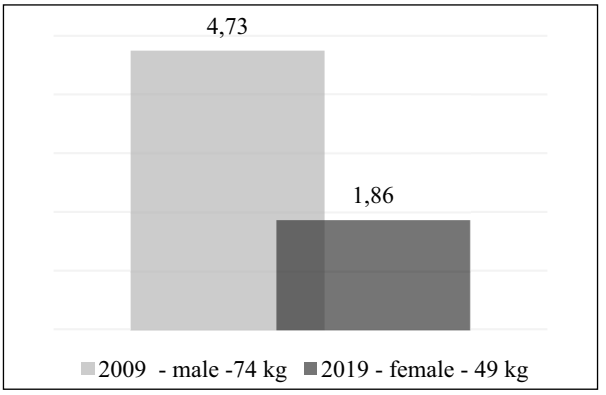

Figure 5. *Coefficient of intensity of the kicks*

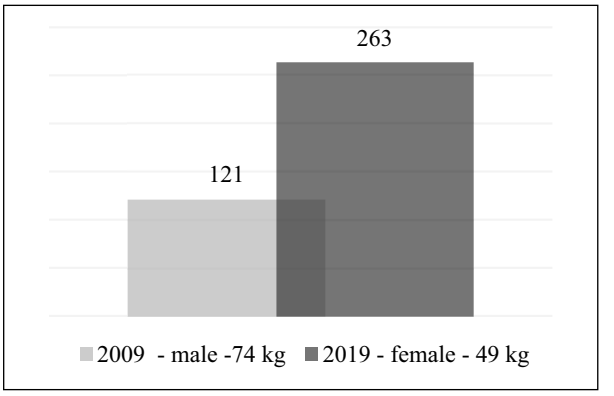

Figure 6. *Highest number of kicks in a match*

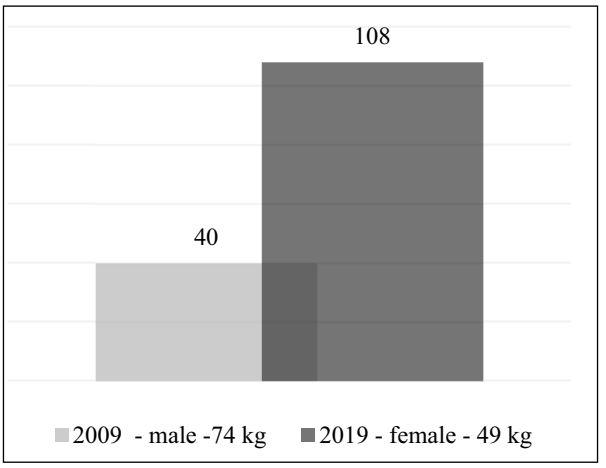

Figure 7. *Lowest number of kicks in a match*

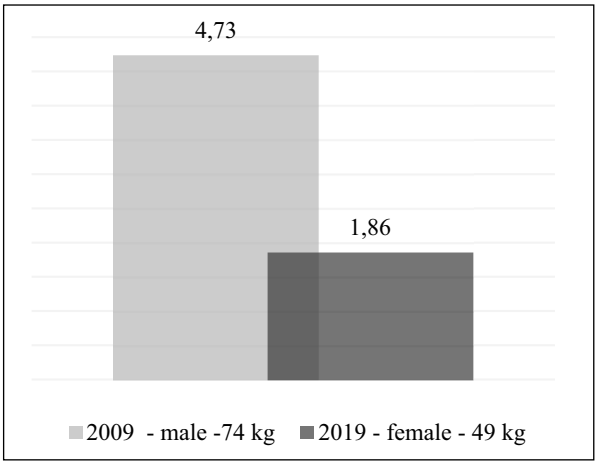

Figure 8. *Coefficient of intensity*

DISCUSSION

Comparing the available data, namely the men's 74 kg category data from the 2009 World Championships and the women's 49 kg category data, we found interesting results. The average number of strikes per match for the men in 2009 was 76, and the 2019 average for the women was 193. This is the number combined for both competitors. The difference is almost 3 times more in favor of women. It is logical to assume that in an analysis of the men's categories from 2019, the indicators for men will be higher than those for women. We suggest that future studies be conducted in the male divisions as well so that the comparison can be correct in terms of gender and weight. However, we believe that the World Federation has realized one of its main trends, that is that the changes in the rules aim to stimulate active play by both competitors.

Due to improved and new electronic systems, as well as constant rule changes, competitors began to look for new techniques to score points. Most of these shots were hardly used until now, but after the rule change, some of them became even basic. A typical example in this regard is yop chagi, this shot was not scored by the judges, but now it has become one of the main shots, and the way of conducting the game has radically changed. Kicks that, in the absence of the PSS, would not be scored by the judges, are now becoming a must-have weapon in the arsenal of any successful Taekwondo competitor. Of course, the 2009 World Championships was the first to have an electronic scoring system. However, it has long since been replaced due to its imperfections. In the 2019 Grand Prix Sofia Daedo 2 electronic system was used. Daedo 1 was introduced 2 years after the World Championships in Denmark, and Daedo 2 was introduced in 2017. It is clear to everyone that the human factor cannot cover and score objectively all the shots. For taekwondo competitors, this is more than obvious, watching taekwondo matches from over 10 years ago and comparing them to their experiences on electronic equipment. Very often light blows, which are apparently not delivered with great force, score points. Such shots would never have been scored

before the availability of electronic equipment. It is still debatable whether taekwondo 10 years ago was better than it is now, but no one denies the advantage of the electronic scoring system, which puts competitors on a level playing field, at least in terms of scoring. Many of the kicks that modern electronic systems count are very likely not counted by the Lajust system used in 2009. The kicks used in the 2009 meets scored an average of 8.2 points per match, while women's kicks from 2019 scored an average of 31 points. The increase in points scored is almost 400%.

The comparative analysis between elite taekwondo players shows how much taekwondo has changed compared to 10 years ago. It is extremely important to monitor the trends in the development of the rules and the corresponding opportunities to adapt techniques to them, but it is even more important to try to predict what these changes will be in order to prepare taekwondo players earlier. The number of kicks in a Taekwondo match compared to 10 years ago has increased tremendously, which means that the requirements in terms of speed and strength endurance are even greater. Coaches should pay special attention to the number of kicks that are taken in a match and model practice matches with that number of shots taken.

REFERENCE

Andonov, K. (2004). Izsledvane efektivnostta na funktsionalnata struktura na gimnastikata v natsionalnata sistema za fizichesko vazpitanie. Sofia.

Andreev, P. (2010). *Sportna gimnastika i tvorchestvo - metodologiya za otkrivane na novi uprajnenia. Sofia:* NSA press.

Avramov, D. (2010). Analiz na svetovnoto parvenstvo po taekuondo 2009. *Sport and science* (pp. 34-38). Sofia: NSA press.

Avramov, D. (2012). Creating a system for difficulty evaluation of taekwondo kicks. *XVI International scientific congress "Sport for all" and VI International scientific congress "Sport, stress, adaptation"* (pp. 107 - 109). Sofia: NSA press.

Federation, W. T. (2022). *Competition Rules & interpretation*. Retrieved from www.worldtaekwondo.org: World Taekwondo Federation (2022): Competition rules & interpretation available at: http://www.worldtaekwondo.org/viewer_pdf/external/pdfjs-2.1.266-dist/web/viewer.html?file=http://www.worldtaekwondo.org/att_file/documents/WT%20Competition%20Rules%20%20Interpretation%2 (Accessed on 24 September 2022).

Kim, J. R. (1986). *Taekwondo:basic techniques & taegeuk poomsae. Vol. 1* . Seoul: Seo Lim Publishing Company.

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APPLICATION OF A SYSTEM OF TECHNICAL AND TACTICAL EXERCISES IN RAFTING

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ABSTRACT
The development of the methodology of the special training of highly qualified female rafting athletes in the past years is closely related to the precise coordination of the training system with the specific requirements of the sport-competitive activity. This happens mainly at the expense of the means by which the special strength and technico-tactical qualities are developed, which poses the problem of searching for new means and methods of special physical training. In the present study, the effectiveness of the application of the author's experimental system of technico-tactical exercises in rafting sports is tested. The subject of the research are exercises for special training. The object of research are the characteristics of development and improvement of technico-tactical qualities of highly qualified female rafting athletes. Ten female rafting athletes from the two leading Bulgarian sports clubs in this sport - SC KK "NSA - Vasil Boyanov", Sofia, Bulgaria and SC "Vento", Plovdiv, Bulgaria were studied. The methodology of the study consists of a literature study and conducting a pedagogical experiment with 18 tests to determine the level of general and special training of highly qualified female rafting athletes. Methods of mathematical-statistical analysis of data are analysis of variation and comparative analysis of Student`s t-criterion. The analysis of the results showed that the system is focused on the development of several basic exercise systems, but the means aimed at the development of special physical training and technical-tactical mastery dominate. The results of the study have immediate practical-applied value both for the optimization of special training of highly skilled female rafting athletes and for subsequent and further research on the topic.

Keywords: *rafting, competitors, technico-tactical, special training*

INTRODUCTION

Rafting is one of the sports that provide overall physical development. This is due to the involvement of all muscle groups in the performance of the paddling. Special rafting training of highly qualified female competitors is a process of developing physical abilities and qualities that meet the specific requirements of competitive activity. The search for new means and methods of special physical training appears to be a topical problem of the theory and methodology of rafting sport. On the basis of our research, the traditional rafting training methodology in Bulgaria is limited to rafting in fast-flowing rivers and paddling in quiet waters, without purposeful use of special technical and tactical exercises, which determines the need to improve its content.

The application of a training system of technico-tactical exercises in sports training is related to the definition of the level of general and special training of female rafting competitors and their technico-tactical performance. In the monograph by V. Bachev (2019) methods, research, scientific results, and conclusions are represented, which form the tendencies of realization of control over the state of different physical qualities of rowing competitors.

The combination of almost identical natural conditions and the availability of fast water of class 2 and class 3 difficulty on the rivers in Bulgaria was the basis for the development of the author's training system of technico-tactical exercises for special training of high qualified rafting competitors. *The aim* of the study is to analyze the effectiveness of the application of an Experimental training system of technico-tactical exercises in the special rafting training of highly qualified female athletes.

METHODOLOGY

The methodology of the research consists of literature research and conducting a pedagogical experiment with 18 tests to determine the level and performance of general and special training of highly qualified female rafting competitors.

A testing battery has been developed that includes various specific and non-specific tests (Hristov, 2015). In the time back she was repeatedly further developed and refined, and we believe that in its present form it is sufficiently informative about the functional condition of highly qualified female rafting competitors.

The testing battery to control the physical condition of highly qualified female rafting competitors was

performed during the competition period within one week (7 days) in two stages in three training sessions, with a rest interval of not less than 60 min between each test. By first performing an anthropometric measurement of each participant in the scientific experiment: age, weight, height - standing, sitting, kneeling, arm extension, sports experience, etc. (Ayan & Yuksek, 2018).
Methodological instructions for conducting testing to assess the sports training of rowers are described by Bulgarian authors in "System for assessing the sports training of students in sports schools" (Gospodarsky, Treneva, 2012).
The subject of the study are technico-tactical exercises for special training of highly qualified female rafting competitors.
The object of research are the specifics of the development and improvement of technico-tactical qualities of highly qualified female rafting competitors.

Ten (10) highly qualified female rafting competitors were studied from the two leading Bulgarian sports clubs in this sport - SC KK "NSA - Vasil Boyanov", town of Sofia, and SC "Vento", Sofia. Plovdiv. All the studied persons are part of the representative team of the Republic of Bulgaria who participates in international rafting competitions.

The study was conducted at the rowing base "Sredets", ez. Pancharevo, Sofia city district and on the Struma River in the area of Kresna Gorge, Blagoevgrad district.
Methods for mathematical and statistical analysis of the data were analysis of variance and comparative analysis by Student's t-criterion. The study results have immediate practical-applied value both for optimizing special training of highly qualified female rafting competitors and for subsequent and further research on the topic.

RESULTS

Tables 1.1 and 1.2 present the analysis of the variance of the anthropometric measurement data of high-performance female rafting competitors from the experimental and control groups. The following anthropometric indices are shown: age, sports experience, height, weight, sitting height, kneeling height, and horizontal extension.

Table 1.1 *Mean values and trait variability of age and anthropometric characteristics of female rafting competitors in control group*

Indicators		n	X min	X max	R	X	S	V	As	Ex
1.	Age	5	24.00	30.00	6.00	25.80	2.387	**5.70**	2.043	4.423
2.	Sports experience	5	5.00	14.00	9.00	9.80	3.271	10.70	-.420	1.220
3.	Height	5	161.00	179.00	18.00	168.60	7.021	49.29	.651	.143
4.	Weight	5	53.10	68.60	15.50	59.04	7.051	49.72	.592	-2.499
5.	Sitting height	5	118.20	135.20	17.00	126.30	7.953	63.26	.444	-3.009
6.	Kneeling height	5	116.50	130.00	13.50	123.98	5.968	35.62	-.452	-2.540
7.	Horizontal extension	5	155.00	182.10	27.10	168.74	11.58	**134.15**	-.048	-2.317

Table 1.1 shows the control group's results, in which the mean height of the female rafting competitors was 168.60 ± 7.02 cm, and the mean weight was 59.4 ± 7.05 kg. In both parameters, the coefficient of variation was large (49.29% and 49.72%, respectively), indicating low homogeneity of the group in terms of anthropometric data.

Table 1.2 *Mean values and variability of traits of age and anthropometric characteristics of female competitors of experimental group*

Indicators		n	X min	X max	R	X	S	V	As	Ex
1.	**Age**	5	21.00	33.00	12.00	27.20	5.495	24.25	.272	-2.697
2.	**Sports experience**	5	11.00	22.00	11.00	14.00	4.636	21.50	1.881	3.558
3.	**Height**	5	155.30	172.80	17.50	162.78	6.831	46.67	.711	-.179
4.	**Weight**	5	49.60	73.70	24.10	58.04	9.486	**89.99**	1.444	2.348
5.	**Sitting height**	5	122.00	134.10	12.10	128.18	5.250	27.56	.194	-2.402
6.	**Kneeling height**	5	117.20	129.00	11.80	123.06	4.589	21.06	0.088	-.875
7.	**Horizontal extension**	5	156.20	174.20	18.00	162.80	7.704	59.36	.0918	-.679

Table 1.2 presents the results of the analysis of variance for the female competitors in the experimental group. The mean height of the competitors in this group was 162.78 ± 7.02 cm and the mean weight was 58.04 ± 9.48 kg. Here, also as in the control group, the coefficient of variation for both parameters was large (46.67% and 89.99%, respectively), indicating a weak homogeneity of the group in terms of anthropometric data.

The mean values of age and sports experience in the control group were: age 25.80 ± 2.38, sports experience 9.80 ± 3.27 with a coefficient of variation 5.70% and 10.70%, the experimental group were: age 27.20 ± 5.49, sports experience 14.00 ± 4.63 with a coefficient of variation as follows: 24.25% and 21.50% respectively.
The analysis of the anthropometric measurement test results of the control group showed a relatively small coefficient of variation, indicating strong homogeneity of the group in terms of the indicators of age and sports experience.

Tables 2.1 and 2.2 show the variance analysis results, including indicators to determine the level of the general physical condition of the studied highly qualified female rafting competitors from the control group.
The coefficients of variation of the CFP test indicators with a small percentage of variation and strong homogeneity of the control group were: Test 2 Pulling a 40kg bar from the bench with a coefficient of 8.50%, and Test No. Running 100m with a coefficient of 2.29%, which showed strong homogeneity of the control group in terms of test battery indicators. The mean and standard deviation of Test No. indicators were 27.00±2.9 repetitions in 1 min, and for Test No. as follows - 18.38±1.4 repetitions in 1 min.

Table 2.1 *Mean values and variability of general characteristics of the physical condition of highly qualified female rafting competitors from a control group.*

Indicators		n	X min	X max	R	X	S	V	As	Ex
1.	**Pushing on bar 30kg.**	5	15.00	30.00	15.00	23.00	6.08	37.00	-.133	-1.422
2.	**Pulling a bar 40kg**	5	23.00	30.00	7.00	27.00	**2.91**	**8.50**	-.605	-1.599
3.	**Push-ups**	5	14.00	37.00	23.00	28.20	9.20	84.70	-1.013	.522
4.	**Running on 100m.**	5	16.50	20.37	3.87	18.38	**1.54**	**2.39**	.017	-1.359
5.	**Running on 800m.**	5	198.47	222.85	24.38	206.73	9.80	96.18	1.468	1.996
6.	**Swimming on 100m.**	5	73.00	155.00	82.00	107.24	34.07	1161.3	.398	-.926
7.	**Throwing a ball 3kg.**	5	180.00	337.00	157.00	271.80	61.65	3801.7	-.737	.086
8.	**Throwing a ball 3kg.**	5	172.00	340.00	168.00	265.80	67.64	4575.2	-.536	-1.152

Table 2.2 *Mean values and variability of general physical condition traits of highly qualified female rafting competitors from the control group (second testing of control group subjects).*

Indicators		n	X min	X max	R	X	S	V	As	Ex
1.	**Pushing on bar 30kg.**	5	30.00	47.00	17.00	38.00	7.17	51.50	.386	-2.208
2.	**Pulling a bar 40kg**	5	25.00	43.00	18.00	31.80	6.76	45.70	1.433	2.741
3.	**Push-ups**	5	30.00	51.00	21.00	40.60	9.07	82.30	.186	-2.402
4.	**Running on 100m.**	5	16.82	18.85	2.03	17.73	**.866**	**.750**	.221	-1.978
5.	**Running on 800m.**	5	197.51	220.65	23.14	208.53	10.32	106.5	.404	-2.750
6.	**Swimming on 100m.**	5	64.85	155.00	90.15	98.56	35.42	1254.7	1.209	1.323
7.	**Throwing a ball 3kg.**	5	279.00	415.00	136.00	349.00	58.86	3465.5	-.334	-2.490
8.	**Throwing a ball 3kg.**	5	300.00	438.00	138.00	376.80	60.77	3693.2	-.540	-2.562

Most of the control group's general conditioning test scores had a normal frequency distribution except for Test No. 6 100 m freestyle, No. 7 Ball throw from sitting position with left hand, and No. 8 Ball throw with right hand (Table 2.1 and Table 2.2).
Tables 3.1 and 3.2 present the analysis results of vari-

ance analysis, including indicators to determine the level of the general physical condition of the studied highly qualified female rafting athletes of the experimental group. Test No. 4 with a coefficient of variation in the first testing - 0.450% and an average value of the indicator of 18.34±0.67 sec, and in the second testing - a coefficient of 0.75% and the average value of 17.73±0.86 sec, which indicates a very strong homogeneity of the experimental group in terms of speed capabilities of female athletes.

Most parameters of the general physical condition test of the experimental group had normal distribution except Test No. 6 100 m freestyle, No. 7 Throwing the ball from sitting position with left hand and No. 8 Throwing the ball with right hand (Table 3.1 and Table 3.2).

Table 3.1 *Mean values and variability of traits of general physical condition of highly qualified female rafting competitors from experimental group.*

Indicators		n	X min	X max	R	X	S	V	As	Ex
1.	**Pushing on bar 30 kg**	5	30.00	47.00	17.00	38.00	7.17	51.500	.386	-2.208
2.	**Pulling a bar 40 kg**	5	25.00	43.00	18.00	31.80	6.76	45.700	1.433	2.741
3.	**Push-ups**	5	30.00	49.00	19.00	37.80	9.41	88.700	.561	-3.101
4.	**Running on 100 m**	5	17.60	19.33	1.73	18.34	**.670**	**.450**	.639	.127
5.	**Running on 800 m**	5	200.77	220.21	19.44	209.69	8.39	70.427	.439	-2.415
6.	**Swimming on 100 m**	5	66.66	150.00	83.34	99.14	33.07	1093.7	.981	.504
7.	**Throwing a ball 3 kg**	5	279.00	415.00	136.00	349.00	58.86	3465.5	-.334	-2.490
8.	**Throwing a ball 3 kg**	5	300.00	438.00	138.00	376.80	60.77	3693.2	-.540	-2.562

Table 3.2 *Mean values and variability of traits of general physical condition of highly qualified female rafting competitors from experimental group (second testing of control group subjects)*

Indicators		n	X min	X max	R	X	S	V	As	Ex
1.	**Pushing on bar 30kg.**	5	30.00	47.00	17.00	38.000	7.176	51.500	.386	-2.208
2.	**Pulling a bar 40kg**	5	25.00	43.00	18.00	31.800	6.760	45.700	1.433	2.741
3.	**Push-ups**	5	30.00	51.00	21.00	40.600	9.071	82.300	.186	-2.402
4.	**Running on 100m**	5	16.82	18.85	2.03	17.734	**.866**	**.750**	.221	-1.978
5.	**Running on 800m**	5	197.51	220.65	23.14	208.53	10.322	106.554	.404	-2.750
6.	**Swimming on 100m**	5	64.85	155.00	90.15	98.562	35.422	1254.73	1.209	1.323
7.	**Throwing a ball 3kg**	5	279.00	415.00	136.00	349.00	58.868	3465.50	-.334	-2.490
8.	**Throwing a ball 3kg**	5	300.00	438.00	138.00	376.80	60.771	3693.20	-.540	-2.562

The differences between the mean values of the studied parameters with normal distribution in control and experimental groups were verified by Student's t-test for independent samples and the difference between those with a distribution different from the normal distribution by the non-parametric Mann-Whitney U-test.

Table 4.1 *Dynamics of the results of the physical conditioning indices of the highly qualified female rafting competitors of the control group*

Indicators		n	$\bar{x}$	t	df	Sig.(2-talled)	p
1.	**Pushing on bar 30 kg**	5	-6.20±4.76	-2.91	4	.044	p <.05
2.	**Pulling a bar 40 kg**	5	0.80±4.65	0.38	4	.721	p<.05
3.	**Push-ups**	5	-3.40±3.20	-2.36	4	.077	p <.05
4.	**Running on 100 m**	5	0.04±1.46	-0.18	4	.432	p<.05
5.	**Running on 800 m**	5	-0.09±1.10	-2.36	4	.207	p <.05
6.	**Swimming on 100 m**	5	-0.75±1.85	-0.91	4	.334	p<.05
7.	**Throwing a ball 3 kg**	5	-77.20±72.46	-0.91	4	.204	p <.05
8.	**Throwing a ball 3 kg**	5	0.76±3.68	0.46	4	.144	p<.05

Table 4.1 *Dynamics of the results of the physical conditioning indices of the highly qualified female rafting competitors of the experimental group.*

Indicators		n	$\bar{x}$	t	df	Sig.(2-talled)	p
1.	**Pushing on bar 30kg.**	5	-6.00±1.34	-1.00	4	.374	*p* <.05
2.	**Pulling a bar 40kg**	5	1.60±3.57	-1.00	4	.374	*p<.05*
3.	**Push-ups**	5	-5.00±3.93	-2.84	4	.023	*p* <.05
4.	**Running on 100m.**	5	0.60±0.61	2.20	4	.046	*p<.05*
5.	**Running on 800m.**	5	1.16±2.28	0.91	4	.207	*p* <.05
6.	Swimming on 100m.	5	0.58±3.33	0.39	4	.358	*p<.05*
7.	**Throwing a ball 3kg.**	5	-28.60±49.43	-1.29	4	.133	*p* <.05
8.	**Throwing a ball 3kg.**	5	-9.60±5.85	-3.66	4	.011	*p<.05*

After the sample was tested with Student's t-criteria for related samples, it can be concluded that there was no statistically significant difference between the results of the control and experimental group on the effect of the system on the overall physical condition of female competitors.

The results of this study will provide information that can help coaches and competitors improve performance and develop sport-specific rafting training programs that are based on scientific research.

DISCUSSION

Based on our study, Bulgaria's traditional rafting training methodology is limited to whitewater rafting in fast-flowing rivers and paddling in quiet waters, without purposeful use of specific technical and tactical exercises, which has been identified as the need to improve its content.

CONCLUSION

The traditional method of imparting rowing techniques in still and fast waters has been improved in content. The duration and number of repeats of the strokes and elements of the rowing technique in training are defined, taking into account the technical difficulties of the motor action and the resulting fatigue processes. The dose of the technical exercise is adapted to the individual level of preparedness of the athletes and to the number of obstacles to be overcome: "back gates", "straight gates" and their combinations.

Introducing an experimental training system of technical-tactical exercises in the special training of highly qualified female rafting competitors allows achieving higher levels of technical-tactical mastery. This is due to the result of building new tactical models, technical skills, and higher general and special physical level of female racers, which allows the implementation of components of special training and technical-tactical qualities of female competitors during competition with higher efficiency.

The results of this study will provide information that can help coaches and competitors improve performance and develop sport-specific rafting training programs that are based on scientific research.

REFFERECES

Ayan, V. & Yuksek, S. (2018). The study of somatotypes of the Turkish Nacional Rafting Team, *International Journal of Sport. Exercise and Traning Scienes*, Vol. 4, issues 1 (pages 18-25), Instabul, 2018.

Bachev, V. (2019). *Kontrol na fizicheskata podgotovka v grebaneto.* Monografia, NSA, Sofia.

Gospodarski, N. (2012). *Sistema za ocenka na sportnata podgotovka na ychenicite v sportnite ychilishta,* 194-196, Bolid INS, Sofia, 2012.

Treneva, V. (2012). *Sistema za ocenka na sportnata podgotovka na ychenici v sportnite ychilishta*. Bolid INS, Sofia, 2012.

Hristov, R. (2015). *Grebane-trenirovka*. NSA, Sofia, 2015.

Grizlova, N., & Grizlov, S. (2009). *Primernja sportna programa, Podgotovka na grebci.* DUSSH&SDSSHOR rafting. Doktorska disertasiya, Sochi, 2009.

Petrov, S. (2009). *Uroci po rafting. Dnevnik na sportmen.* Rafting federacion, Sanct Peterburg.

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MODELLING COMPETITION PERIODIZATION DURING THE OLYMPIC YEAR IN THE DISCIPLINE 110 M HURDLES (MEN)

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ABSTRACT
Competition periodization in contemporary sports is a difficult task composed of basic rules of training periodization, adaptation, and a busy competition calendar. Influence on the process has many outer factors. Establishing the competition calendar in the year of the main competition (Olympic Games) and secondary ones is a great difficulty. These difficulties are compounded by aggravating factors such as a fading global pandemic and travel difficulties. In addition, participation in commercial tournaments is another major part of the competition calendar.
The main aim of the following study is to analyze and model the competition periodization of elite 110 m hurdles during the Olympic year (2021). Respondents are all participants in the Olympic tournament in the chosen discipline – in total, 39 athletes.
We found different tactics regarding participation in competitions during the Olympic year. Also, we found a different pattern of sports result utilization before a major competition. All finalists do not take part in the competition 20 days before the heats of the Olympic games. Some athletes participate in 60 m hurdles discipline just to check their sports form, others search for top performance in indoor competitions. The number of race days varies between 10 and 21 an (average of 16) for the finalists. After participating in the Olympic games, most of the athletes participated in a few commercial tournaments and no later than the middle of September, they finished race season.
Based on the results, we can improve the training process and competition planning based on the experience of world-class hurdlers. We must consider that sometimes participation in the competition is canceled due to other factors such as injuries or travel problems. Also, we propose annual competition models based on elite hurdler performance during the Olympic year.

Keywords: *competition, periodization, 110 m hurdles, men, Olympic games*

INTRODUCTION

Athletics has a great variety of disciplines divided into groups. The running event group is one of the most spectacular and difficult (Doherty, Kernan, 2017). There flashes the hurdle running event with its technical complexity and demands on human abilities as speed and strength combined with flexibility and coordination during the hurdle clearance.

Interest for us is the discipline 110 m hurdles for men because it is the first discipline from the hurdle events in history (Quercetani, 2009). Also, it is one of the most studied events regarding hurdle running technique and some aspects of training (Gutev, Slavchev, 2011).

Competition periodization in contemporary sports is a difficult task composed of basic rules of sports training periodization, adaptation, and a busy competition calendar (Dimova, 2020). Influence on the process has many outer factors such as travel plans, athletic managers, and their ability to find competitions, health status, etc.

But after a deep analysis of methodical literature, we could not find detailed information regarding modeling competition periodization for the studied discipline during the Olympic year. (Diankov, Marinova, 2022)

METHODS

The main aim of the following study is to analyze and model the competition periodization of elite 110 m hurdles during the Olympic year (2021).

To achieve the aim, the following tasks were performed:

1. Collecting information for respondents' participation in official competitions during the Olympic 2021 from World Athletics (WA, 2022) official website.
2. Statistical analysis applying frequency and descriptive analysis.
3. Expert analysis of gathered data.

Respondents are 39 hurdlers participating in the Olympic games tournament in Tokyo (Japan) in 2021. We analyzed the participation of all athletes in the Olympic games' tournament in the 110 m hurdle running during the whole of 2021. Interest for us is the competition days when running 60 m hur-

dles (indoor) and 110 m hurdles (outdoor), their main disciplines, trying to find similar patterns of competition periodization. Age was also the subject of analysis to reveal if there are certain differences regarding the age and different stages of the competition (heats, semi-finals, final). Country of origin was subjected to frequency analysis to reveal the influence of different training schools over the discipline in the world.

RESULTS

The first thing of our study is to reveal whether there is any age variation among participants based on their ranking during the Olympic games. Age is an important base from which the analysis of periodization starts (Gutev, Dimova, 2021). Table 1 presents a detailed descriptive analysis of all respondents divided by the stage of the tournament in which they participate. From this data, we can note that the average age is similar no matter whether we are analyzing finalists of participants in the heats. This is confirmed by the variance coefficient (V) number – ≈12%. Also, the youngest and oldest participants' numbers are very similar. We can conclude that we do not find differences between participants in the heats, semi-finalists, and finalists.

Table 1. *Respondents' age descriptive analysis*

Respondents	n	X min	Xmax	R	X	S	V	As	Ex
All participants	39	20	34	14	27.44	3.31	12.08	-0.392	-0.069
All semi-finalists	24	21	34	13	27.29	3.06	11.20	-0.152	0.016
All finalists	8	21	31	10	27.50	3.38	12.29	-1.228	0.716

In Table 2, we present a frequency analysis of all hurdles country of origin to find their dominance from certain countries, and from there, we can point our attention to the specifics of their modeling during the Olympic year. The country with the greatest number of participants is the USA, with 4 athletes (10.3% of all participants), followed by Brazil, Great Britain, and Jamaica, with 3 hurdlers. Results from studies by Gutev (2020) reveal that the same country (except Japan) dominating the world elite in 110 m hurdles.

We find certain countries (such as Kuwait, Mauritius, and Senegal) to take part for the first time in such a major competition in this event with hurdlers without any serious experience in the discipline.

Table 2. *Frequency analysis of Olympic games participants in the discipline 110 m hurdle*

Country	Frequency	Percent (%)	Cumulative Percent	Country	Frequency	Percent (%)	Cumulative Percent
USA	4	10.3	10.3	Cyprus	1	2.6	69.2
Brazil	3	7.7	17.9	Finland	1	2.6	71.8
Great Britain & N.I.	3	7.7	25.6	Germany	1	2.6	74.4
Jamaica	3	7.7	33.3	Greece	1	2.6	76.9
France	2	5.1	38.5	Hong Kong, China	1	2.6	79.5
Italy	2	5.1	43.6	Hungary	1	2.6	82.1
Japan	2	5.1	48.7	Kuwait	1	2.6	84.6
Australia	1	2.6	51.3	Mauritius	1	2.6	87.2
Barbados	1	2.6	53.8	Poland	1	2.6	89.7
Belarus	1	2.6	56.4	Senegal	1	2.6	92.3
Belgium	1	2.6	59.0	South Africa	1	2.6	94.9
China	1	2.6	61.5	Spain	1	2.6	97.4
Chinese Taipei	1	2.6	64.1	Virgin Islands	1	2.6	100.0
Comoros	1	2.6	66.7	**Total**	**39**	**100.0**	

A summary of the total number of competition days (only hurdle events, 60 m hurdles indoor and 110 m hurdles outdoor) from all respondents is presented in Figure 1. We find that there are three main peaks of competition days – three main peaks of performance in the sport form of athletes.

The first one is at the beginning of the calendar year – February – respondents participate mostly in the discipline of 60 m hurdles (indoor). But we find few exceptions, mainly from athletes from Australia and Chinese Taipei participating in 110 m outdoor competitions. This is mainly since during winter months in Europe and North America, in other parts of the world, there is a summer season, and outdoor competitions can be organized. We can stand out that this is not a tendency, it is an exception. The greatest number of respondents have between 1 and 5 race days indoors as part of their training program for the main event during the summer season – the Olympic games.

The second peak of competition race days (the second peak of performance) is between the end of May and June, when all hurdlers check the level of their training programs, make race simulations, and participate in commercial tournaments. A small number of races are found in July (note that there are at the beginning of the month).

The main performance peak (the Olympic games) is in August, during which all respondents have competition days.

We found a tendency not to participate in official competitions two to three weeks before the main event for the year. This is valid for all respondents. Also, after the OG, we find a window of 2 to 3 weeks again without participation in tournaments. Commercial tournaments for Olympians start at the end of August and are not more than 3 or 4 race days (mainly Diamond league and commercial tournaments in Europe). We find a small number of race days in October and December – they are performed by athletes from Asia and Australia – again due to climate specifics.

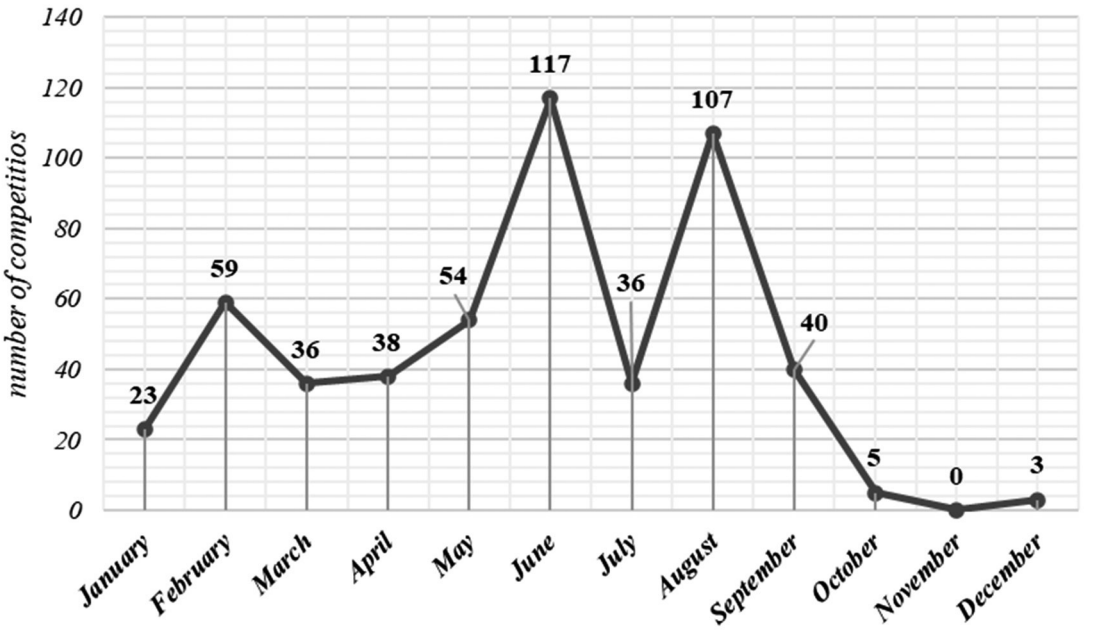

Figure 1. *Number of competitions (in the disciplines 60 m hurdles and 110 m hurdles) monthly of all Olympic games' participants in 110 m hurdles (total 39 athletes)*

A more detailed analysis of competition days is presented in Figure 2. There we see information regarding every week of the year (52 in total for 2021). Here we find several peak weeks with a more intense competition schedule. During the winter season (indoor season), we can point out week 6 (February) and week 9 (March), but also, the week between them can be summarized as a winter competition block (if we use block planning). As a middle competition, block stands out in week 16 in April. And the early competition stages of the summer race season are between week 22 and week 25 of June and the first

week of July. Of course, it is visible that competition number one for the year (week 31) is highlighted. After that, we found two weeks of very low competition activity. From week 34 (end of August) to week 38 in September, we found a decrease in competition activity, mainly with commercial competitions.

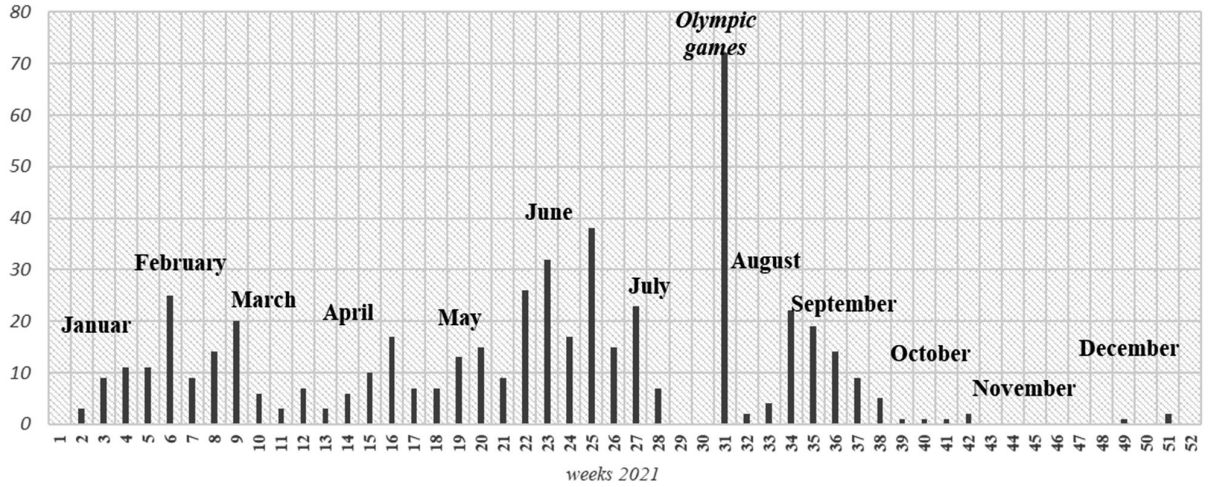

Figure 2. *Number of competitions (in the disciplines 60 m hurdles and 110 m hurdles) weekly of all Olympic games' participants in 110 m hurdles (total 39 athletes)*

Tables 3, 4, and 5 present descriptive analyses of the competition days of respondents based on their performance: all athletes (39 hurdlers), athletes reached semi-finals (24 hurdlers), and athletes reached finals (8 hurdlers).

In all groups, we find a high level of variance on the index presenting several competition days after the main start of the year. This means that some of them chose not to start in commercial tournaments and others have more intense competition schedules to compensate for underperformance during the main start.

The main index is several competition days before the main start, which varies between 4 and 26 (range 22) for all participants. The numbers for the finalists vary between 10 and 21, which leads us to the conclusion that this number of official race days in hurdles is close to optimal. Prior 10 race days in both indoor and outdoor races is not enough to develop performance. The number on this index between all participants and those racing in the semi-finals is close.

Table 3. *Competition participation of all participants in Olympic games (OG)*

All participants in OG	n	X min	Xmax	R	X	S	V	As	Ex
number of competitions in 2021	39	4	26	22	13.28	5.49	41.34	0.058	-0.529
number of competitions before OG	39	1	21	20	9.31	4.76	51.18	0.422	-0.242
number of competitions after OG	39	0	7	7	2.13	1.96	92.22	0.714	0.032

Table 4. *Competition participation of semi-finalists in Olympic games (OG)*

All semi-finalists in OG	n	X min	Xmax	R	X	S	V	As	Ex
number of competitions in 2021	24	6	26	20	15.38	4.83	31.45	0.188	-0.38
number of competitions before OG	24	2	21	19	10.29	4.87	47.30	0.478	-0.237
number of competitions after OG	24	0	7	7	2.71	2.03	75.02	0.467	-0.053

Table 5. *Competition participation of finalists in Olympic games (OG)*

Finalists in OG	n	X min	Xmax	R	X	S	V	As	Ex
number of competitions in 2021	8	10	21	11	16.00	4.07	25.44	-0.034	-1.279
number of competitions before OG	8	4	16	12	10.00	3.96	39.64	-0.294	-0.315
number of competitions after OG	8	0	7	7	3.00	2.93	97.59	0.547	-1.596

DISCUSSION

Modeling competition periodization during the Olympic year is a process connected to many factors, some of them controllable, others were just taken in mind. Based on our research data, we can define certain periods of the year preferred for winter competitions (mainly 60 m hurdles) and four main competition periods during the summer race season. Based on this information, we can adjust the training schedule to optimize sports performance:

- Pre-early starts – test competition in April where we suppose that training volume and intensity are too high to achieve good results.
- Early starts – mainly between the end of May to the beginning of July when hurdlers set their clock regarding their performance.
- Main competitions (in our case, Olympic games) – the event with maximum performance.
- Late competitions – Mainly commercial tournaments.

Also, we can note certain periodization between race periods during the summer seasons as:

- Two or three weeks not participating in official competition between early starts and the main competition.
- Two or three weeks not participating in official competitions after the main start of the year. Also, some athletes finish their race season after a successful performance in the main competitions.

Hurdlers from Europe, North America, and those who train in these regions have similar periodization. But those from Asia, Australia, and Oceania have winter competition season outdoor, leading to variety in the training programming.

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REFERENCES

Dimova, I. (2020). Analiz na predstavyaneto na elitni desetoboĭtsi mŭzhe. *Sŭvremenni tendentsii, problemi i inovatsii vŭv fizicheskoto vŭzpitanie i sporta vŭv visshite uchilishta (IV Nauchna konferentsiya s mezhdunarodno uchastie pod patronazha na Rektora na UNSS 2019 g.)*; IDK UNSS; str. 225-232. // Димова, И. (2020). Анализ на представянето на елитни десетобойци мъже. *Съвременни тенденции, проблеми и иновации във физическото възпитание и спорта във висшите училища (IV Научна конференция с международно участие под патронажа на Ректора на УНСС 2019 г.)*; ИДК УНСС, стр. 225-232.

Doherty, K., Kernan, J. N. (2017). *Track & Field Omnibook 5th Edition*. Tafnews Press.

Dyankov, V., Marinova, T. (2022). Dinamika na pokazateli kharakterizirashti letniya sŭstezatelen period na finalistite v distsiplinata ovcharski skok ot OI-Tokio'21. sp. *Leka atletika i Nauka*, br. 1 (22), Nauchno izdatelstvo NSA PRES, Sofiya, str. 30-35 // Дянков, В., Маринова, Т. (2022). Динамика на показатели характеризиращи летния състезателен период на финалистите в дисциплината овчарски скок от ОИ-Токио'21. *сп. Лека атлетика и Наука, бр. 1 (22)*, Научно издателство НСА ПРЕС, София, стр. 30-35.

Gutev, Gr., Slavchev, A. (2011). Izsledvane trenirovŭchnata deĭnost v byaganeto na 110 metra prez prepyat·stviya na Ventsislav Radev za uchastieto mu na Svetovnoto pŭrvenstvo v Khelzinki prez 1983 godina, *sp. Leka atletika i Nauka, broĭ 1(11)*, BPS, Sofiya, str. 118-124. // Гутев, Гр., Славчев, А. (2011). Изследване тренировъчната дейност в бягането на 110 метра през препятствия на Венцислав Радев за участието му на Световното първенство в Хелзинки през 1983 година, *сп. Лека атлетика и Наука, брой 1(11),* БПС, София, стр. 118-124.

Gutev, G. (2020). *Retrospektsiya na pravilata, tekhnikata, trenirovkata i postizheniyata v prepyat·stvenoto byagane na 110 metra*. NSA Pres, s. 168. // Гутев, Г. (2020). *Ретроспекция на правилата, техниката, тренировката и постиженията в препятственото бягане на 110 метра*. НСА Прес; с. 168.

Gutev, G., Dimova, I. (2021). Sport realization in age aspect of elite athletes in the discipline 100 m (men). *TRAKIA Journal of Sciences*, St. Zagora: 2003, Vol 19, Suppl. 1, 2021, pp. 552-556.

Quercetani, R. (2009). *A world history of hurdle and steeplechase racing – 1860-2008 Men and women*, EditVallardi.

World Athletics (WA) official website (accessed September 2022) – http://www.iaaf.org/

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THE COORDINATION ABILITIES AND THEIR CONNECTION WITH THE TECHNICAL TRAINING OF 6-7-YEAR-OLD GYMNASTS

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ABSTRACT
In recent years, artistic gymnastics has been characterized by a constantly increasing complexity of the exercises performed. In this regard, the control and assessment of coordination abilities strongly activate the system for sports selection in adolescents. The research aims to establish the connection of coordination abilities with the technical training of young gymnasts. We selected coordination tests to identify the most significant component of its structure in the initial selection in gymnastics. We determined the technical level of the studied gymnasts through expert assessment in natural conditions of competition – State Championship 2022. The object of the research are the coordination abilities in the selection of 6-7-year-old girls, and the subject of the study are the components of coordination and their connection with technical training. In this research, we used the following methods: testing method, expert evaluation method, and mathematical-statistical methods – variation and correlation analysis. The processed results show that the overall score from the coordination tests has a moderate correlation with the technical level of the results taken from the competition. The static equilibrium stability test shows the highest degree of correlation on the technical level of all gymnastic apparatus. The results of the other tests, which showed a lower correlation, remain debatable. In conclusion, we can summarize that establishing the level of coordination skills will help the process of selecting talented gymnasts.

Keywords: *coordination skills, artistic gymnastics, selection, technical training*

INTRODUCTION

The relevance of the problem of sports selection in modern sports not only does not decrease but increases with new force. Some authors (Baranaev, 2009; Nikitushkin, 2009; Guba, 2003; Matveev, 2005) believe that the effectiveness of selection in sports is not good enough. This is related to the fact that the existing practice of selection in sports cannot yet be assessed as sufficiently effective and meeting modern requirements in the rapidly developing elite sport. The relevance of this problem is given by the need to achieve maximum social development of both mass sports and professional sports. The improvement of the sports selection system is also determined by the need for a larger sports reserve for the different gymnastics clubs. Research shows that no more than 25% of those initially engaged in artistic gymnastics reach high sports mastery (Dimitrova, 2015).

In recent years, gymnastics has been characterized by an ever-increasing complexity of the performed exercises, which requires the formation of stable and reliable technical skills. In this regard, the control and evaluation of the coordination abilities at the various stages of the training process not only activates the system for sports selection but also allows us to see at the initial stage those leading factors that will lead to high sports results (Nikolaeva, 2006). For this reason, our research is focused on the correlation and relationship of coordination abilities with the technical training of adolescents.

According to Taran, Vnebrachny, 2007 coordination is part of a person's motor abilities and is an important element of his physical capability. In broad sports practice, coordination abilities are understood as the skill to optimally regulate motor action, accurately, quickly, rationally solve various motor tasks, and perform measured movements in conditions of time deficit in connection with the requirements of sports activity (Lyah, 2010; Kleshtev, 1997). According to specialists (Hadzhiev, Andonov, Dobrev, Petrov, 2011; Nikolaeva, 2006), coordination in artistic gymnastics includes the optimal combination of kinematic and dynamic parameters of the gymnastic exercise, which is the basis of improving technical mastery. Also, the authors believe that it allows a relatively automated flow of specific control processes and movement variability.

The study aims to establish the degree of correlation of coordination abilities with the technical training of young gymnasts. For this purpose, we set ourselves the following tasks.

1. To test gymnastic competitors to establish the level of coordination abilities.
2. To determine the technical level of the gymnasts through expert assessment in natural competi-

tion conditions.

3. To look for a correlation between the female competitors' coordination and technical level.
4. To establish which component of the coordination ability structure is most significant for initial selection.

The object of the study is the coordination abilities in the selection of 6-7-year-old girls, and the subject of the study are the components of coordination and their relationship with technical training.

METHODS

The research aimed at examining separate components of coordination abilities, which we consider significant in implementing initial selection.

Research methods

In order to fulfill the set aim and tasks of the research, we used the following methods: a *study of the specialized literature, expert evaluation, sports-pedagogical testing, mathematical-statistical methods – the variation, and correlation analysis*.

Procedure

The study was carried out in May 2022. with gymnasts from SGK "Levski-Spartak 08" and SK "A-GYM". We organized the research in the gymnastics halls of the stadium "G. Asparuhov" and NSA "V. Levski" Sofia. Twelve girls aged 6-7 years voluntarily participated (in agreement with the parents). Before performing each exercise, detailed instructions and a demonstration were provided. We used a stopwatch, a goniometer, and a ball to carry ou,t the tests. We determined the technical level of the study gymnasts through expert evaluation in natural conditions of two competitions – State Championship, Sofia 2022, and "Bulgaria Cup" city of Varna – 2022.

Measurements and indexes

For the realization of the study, sports-pedagogical testing was conducted. We used a test battery of six exercises that carry information on static equilibrium stability, ability to differentiate, motion reproduction accuracy, and orientation in space.

Description of tests:

Static balance

Test 1 – Static balance without visual control

The gymnast takes a stand with a bent leg raised, hands on hips. On command, she closes her eyes, and the measurement starts. The stopwatch stops at the moment of loss of balance. The goal is to hold this pose for as long as possible. It is measured with an accuracy of 0.1 sec.

Test 2 – "Stork"

The gymnast is standing with a bent leg raised, hands on hips. When ready, she takes a balanced stand with her bent leg raised, and the stopwatch starts. The goal is to hold this pose for as long as possible. The timer stops when the heel of the supporting leg touches the floor. It is measured with an accuracy of 0.1 sec.

Orientation in space

Test 3 – Modified Makarova test

The gymnastic performance of 3 rolls and a 360° jump, move with a balanced walk on a low balance beam, arms at the sides, and hold for 7 seconds in a balanced stand. The stopwatch starts with the first movement. If the gymnast loses her balance, stumbles, or falls from the balance beam, a penalty time of one second is given. The execution time is summed with the penalty time, and the final test time in seconds is reported. It is measured to an accuracy of 0.1 sec.

Differentiation ability

Test 4 – Throwing a ball without visual control

The gymnast throws a lightweight ball (for rhythmic gymnastics) with both hands above the head as far as possible. This is followed by the performance of three trials with closed eyes in order to reach 50% of the achieved result. The best achievement against the requirement is taken. It is measured with an accuracy of 0.5 cm.

Test 5 – Ability to differentiate the position when moving the arms to the side – left and right (Goniometer)

The goniometer is placed on the gymnast's shoulder so that it shows degrees that are chosen arbitrarily by the tester; the subject raises the arm until reaching the limiter. The task is performed three times, after which the limiter is removed, and the gymnast reproduces the movement. The result is the difference between the given hand position and the reproduced one (degrees).

Test 6 – ***Motion reproduction accuracy***

Description of the test for 5-6 years.

From starting position standing, 1 – jumping to a straddled standing, hands on hips; 2 – jump to standing, arms at sides; 3 – jump to a straddled standing, arms up; 4 – jump to starting position. The exercise is shown once to each child individually, after which they must complete it independently. In case of a wrong performance, the exercise is shown again, and the child performs it again. The performance without error is counted.

Description of the test for 7 years.

From starting position standing, 1 - step to the side with the left leg to a straddled standing, raising the left arm forward, the right arm up; 2 – bringing the legs together (right leg next to the left) until standing with arms at the sides; 3 – step with the left foot to a straddled standing, raising the right arm forward, left arm up; 4 – bringing the legs to the starting position standing. The exercise is shown once to each child individually, after which they must complete it independently. In case of a wrong performance, the exercise is shown again, and the child performs it again. The performance without error is counted. This test can also be done with a jump.

Data analysis

The study results were processed using the statistical package SPSS Statistics, version 26, 2019. The following mathematical-statistical methods were applied: *variation analysis* – for defining average values, normality of distribution, and variety of indicators under study and correlation analysis with a simple linear correlation coefficient of Pearson (r) – to establish the presence of correlation between the variable quantities (Gigova, 2019).

RESULTS

The results of the variation analysis of the coordination abilities components show that in two of the tests No. 2 and No. 6, namely "Stork" and "Motion reproduction accuracy", the group is represented as a homogeneous group – the coefficient of variation is from 2.45% to 7.89% (Table 1). In tests No. 1 – "Static balance without visual control", No. 3 – "Orientation in space" and No. 5 (right hand) – "Differentiation of the position when moving the arms to the side" the group is relatively homogeneous – the coefficient of variation is above 12 %. The results reflecting the kinaesthetic differentiation ability, obtained by tests No. 4 – "Throwing a ball without visual control" and No. 5 (left hand) – "Differentiating the position when moving the arms to the side" showed a higher variability and defined the group as non-homogeneous concerning these components. This can be explained by the young age of the examined gymnasts. Around 5-7 years old, children have a low level of development of coordination and unstable coordination of symmetrical movements. For them, motor skills are formed against the background of an excess of orientation and motor reaction, and the ability to differentiate efforts is low.

Table 1. *Variation analysis of the components of coordination abilities*

Indicators	n	Mean	min	max	R	**S**	**V%**	**As**	**Ex**
Test 1	12	11.14	5.00	22.00	17.00	5.15	26.57	0.83	0.18
Test 2	12	4.61	2.49	13.00	10.51	2.80	7.89	2.80	8.61
Test 3	12	24.87	20.80	31.68	10.88	3.48	12.12	0.99	0.03
Test 4	12	17.5	0.00	55.00	55.00	19.94	397.72	0.98	-0.44
Test 5 right hand	12	5.75	0.00	12.00	12.00	4.00	16.02	0.06	-1.03
Test 5 left hand	12	6.00	0.00	15.00	15.00	5.57	31.09	0.45	-0.96
Test 6	12	3.08	1.0	5.00	4.00	1.56	2.45	-0.16	1.40

Table 2 presents the correlation coefficients of the coordination abilities and the technical level of the gymnasts. Statistically significant coefficients are marked with an asterisk (*).

Looking for a correlation between the separate apparatuses and the level of the components of the gymnasts' coordination abilities, a correlation of Test No. 2 for static balance "Stork" with all gymnastic apparatuses is revealed. There is a *significant* correlation with floor exercise – Sofia r = .694*, vault – Varna r = .577*, balance beam – Sofia r = .621*, balance beam – Varna r = .515 (Table 2). As you can see, the correlation is great with the balance beam apparatus in both competitions held, from which we can judge that the test gives reliable information about the technical level of this apparatus. The next test, No. 1, for static balance, also shows a correlation with a large part of separate apparatuses, with a *significant* one with a vault – Varna r = .650*. We can note that the two balance tests correlate with the obtained evaluations of the separate apparatuses in both competitions.

In orientation test – No. 3, "Modified Makarova test," it is noticed that there is a correlation between almost all gymnastic apparatuses. Those that stand out with *significant* correlation are floor exercise – Varna r = -.546 and balance beam – Varna r = -.553. A *moderate* correlation is observed in uneven bars – Varna r = -.459 (Table 2).

To perform any motor actions – from elementary natural movements (holding any posture, walking, running) to technically complex exercises, it is necessary to reach a certain level of spatial orientation. The higher the level achieved, the easier it is to maintain a stable body position.

Table 2. *Correlation analysis of the components of coordination skills and technical level*

	Test 1	Test 2	Test 3	Test 4	Test 5 right hand	Test 5 left hand	Test 6
Vault Sofia	.300	**.491**	-.302	.144	-.028	-.103	.148
Uneven bars Sofia	-.254	.305	-.244	.202	-.089	-.254	-.026
Balance beam Sofia	.464	**.621***	.276	.293	.030	-.354	-.373
Floor exercise Sofia	.441	**.694***	-.097	-.041	.223	-.377	.197
Vault Varna	.650*	.577*	-.240	-.044	-.148	-.070	.268
Uneven bars Varna	-.134	.206	**-.459**	.076	-.423	.001	.313
Balance beam Varna	.341	**.515**	**-.553**	**-.428**	.070	-.056	.326
Floor exercise Varna	**.512**	.376	**-.546**	-.277	-.044	.092	**.445**

*Note. *p < .05; **p< .01*

Another component that stands out is the "Motion reproduction accuracy" test. It has a *moderate* correlation with floor exercise – Varna r = .445, uneven bars – Varna r = .313, balance beam – Sofia r = .373 (Table 2). This test is determined by motor memory capabilities and characterizes the gymnast's ability or inability to quickly master new (including complex coordination) motor actions. A *low* correlation was also revealed between the other kinesthetic differentiation components, "Differentiate the position when moving the arms to the side" and "Ball throwing". This can be explained by poorly developed coordination at this age.

DISCUSSION

The conducted study directed us to some discussion questions related to the relationship between the various components of young gymnasts' coordination and technical training. Static balance and spatial orientation tests have a *significant* correlation on almost all gymnastic apparatuses. This positive relationship between these two components of coordination abilities important for gymnastics has its logical explanation. On the one hand, it is connected with the fact that orientation in space is an integral part of the essence of balance, and on the other, it is part of a whole – the gymnast's coordination abilities. This confirms the thesis of Guba, 2003, that despite the different specificities of the coordination components, they are a whole and have common properties. The research found that these components are the most significant and should find a place in the sports selection system in this sport. The other components – tests No. 4 - "Throwing a ball without visual control", No. 5 – "Differentiation of the position when moving the arms to the side" and No. 6 – "Motion reproduction accuracy" show a *moderate* correlation in the technique of young gymnasts. They are associated with the ability to accurately regulate the spatial, temporal, and dynamic parameters of movement. Moreover, they confirm the experts' opinion that they are of fundamental importance for improving the performance technique in gymnastics.

In conclusion, we can say that the components of coordination abilities we have chosen to have a significant correlation with the level of technical training in gymnastics. This fact confirms the importance of coordination with this sport's high level of technical preparation. That is why we believe that coordination tests conducted by us should be offered and approved during the initial selection, which will support the sports selection process. The research convinced us that it is necessary to raise the control and assessment of coordination abilities to a higher level in all stages of preparation.

REFERENCES

Baranaev, Yu.A. (2009). K probleme sportivnoy orientatsii i otbora v DYuSSh. *Nauchnoe obosnovanie fizicheskogo vospitania sportivnoy trenirovki i podgotovki kadrov po fizicheskoy kulture i sportu*, Materialy mezhdunarodnoy nauchno-prakticheskoy konferentsii, Minsk, 8-9 aprelya 2009 g., tom 2, Minsk

Gigova, V. (2019). *Statisticheski metodi s SPSS Statistics*. Rakovodstvo za studenti ot OKS „Magistar" i ONS „Doktor" na NSA „Vasil Levski", NSA Pres, Sofia

Guba, V. P. (2003). *Osnovy raspoznavania rannego sportivnogo talanta*. Uchebnoe posobie dlya vysshih uchebnyh zavedeniy fiz. kulytury, Terra – Sport, Moskva, s. 208

Dimitrova, B., (2015). Coordination abilities and selection in gymnastics. *Activities in physical education and sport*. Vol. 5, № 2, Skopje, pp. 241-243

Kleshtev, V.N. (1997). *Koordinatsionnye sposobnosti (lovkosty) i ih sovershenstvovanie*. Kolomna

Lyah, V.I., (2010). Ob istorii testirovania dvigatelynyh sposobnostey, *Fizicheskaya kulatura v shkole*, №4, s. 26-3

Matveev, L. P. (2005). *Obshtaya teoria sporta i ee prikladnye aspekty*. 4-e izd., ispr. i dop., Sankt-Peterburg. Lany, s. 384

Nikitushin, V.G. (2009). *Sovremennaya podgotovka yunyh sportsmenov*. Fizkulytura i sport, Moskva

Nikolaeva, E.S. (2006). *Razvitie koordinatsionyh sposobnostey kak uslovie efikasnogo obuchenia 5-7 let uprazhneniyam s predmetami v hudozhesvennoy gimnastike*. Diss., Belgorod

Taran, I. I., Vnebrachy, D. I. (2007). *Koordinatsionnaya podgotovka basketbolistov*. Uchebno-metodicheskoe posobie. Velikie Luki, s. 108 (S grifom UMO)

Hadzhiev, N., Andonov, K., Dobrev, D., Petrov, V. (2011). *Fizicheska podgotovka*. NSA PRES, Sofia

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STUDY ON THE EFFECT OF USING BIOROW TECH SYSTEM FOR IMPROVING SOME TECHNICAL INDICATORS OF THE ROWING STROKE WITH NOVICE ROWERS

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ABSTRACT
The rowing technique is one of the main factors determining good sports results. Many different factors are combined in rowing, but only if the effective technique is understood and its key factors are mastered the rowers would be able to realize the full benefit from training.
The primary purpose of the current research was to determine the effect on some technical indicators after the BioRow Tech system for ergometers was used in training university students – novice rowers.
Methods of the experiment include measuring three variables: the positions of the handle, seat and trunk (at the level of the shoulder joint). The velocities of the legs, trunk, and arms were derived from measured points and used for analyses. BioRow Tech system produces three indicators displayed instantly for the rower to see: Catch Factor, Rowing Style Factor, and Finish Factor. Rowers receive real-time feedback after each stroke.
The received results demonstrate an increase in all the above indicators within the groups of investigated students. It was determined that when rowing with different intensities, the Catch factor increased with an average of d%=75.17, P(t) = 86.6; the Rowing Style Factor with d%=23.25, P(t) = 95.7, and the Finish Factor with d%=33.86, P(t) = 68.3.
The analysis of the results reveals a positive effect on improving the rowing stroke technical indicators. Using the BioRow Tech system on an ergometer could cut down the time novice rowers typically need to improve their rowing technique.

Keywords: *rowing technique, BioRow Tech System, rowing ergometer*

INTRODUCTION

Rowing is a cycle sport which is characterized with complex coordination of the movements, which repeat in a certain sequence over certain intervals. The correct execution of all elements of these movements, or "the rowing technique" is the most important skill every coach should teach their rowers. This, according to a lot of specialists (Tosheva, 1981; Herberger et all, 1983; Nilsen, 2004; Thompson, 2005; Nolte, 2005; Altenburg et all, 2012; Hristov, 2015), is a difficult and lengthy process, and the achievement of the desired result depends on a lot of factors. One of them is the correct learning of the movements from the very beginning and the avoidance of technical mistakes. It is well known that novices learn both correct and incorrect moves easily, and if the latter are memorized, a lot of time and work will be needed to be unlearnt.

Hypothesis

The three most common mistakes in rowing technique can be seen and corrected both on a rowing ergometer and in a boat on the water:

1. "Opening up" (or rolling) of the trunk at the catch.
2. "Grabbing" the arms and shoulders during the first part of the drive.
3. "Throwing" the trunk after the finish of the drive (prolongation of shoulder movement to the bow, when the handle has already changed directions and moves to the stern).

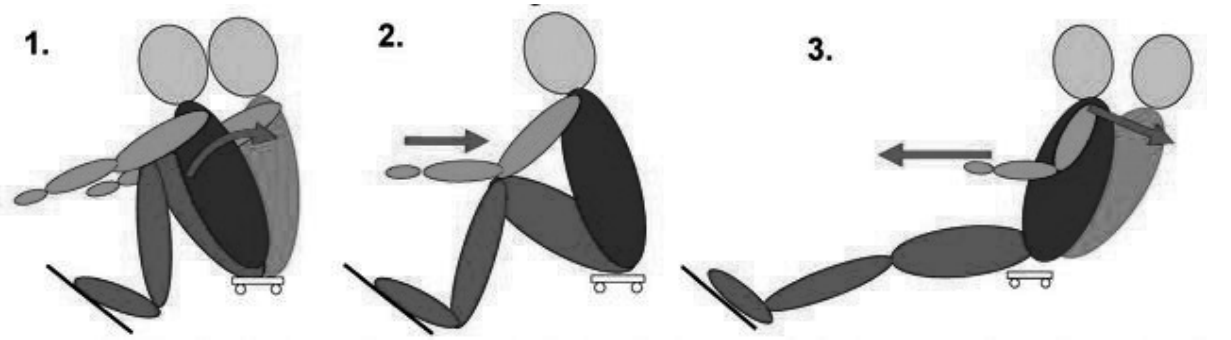

Figure 1. *The three most common mistakes in rowing technique (BioRowTech system for rowing ergometer)*

To avoid these mistakes, it is essential that each novice build a proper technical model (vision) of the rowing cycle, which is not easily done.

In this relation, we wanted to study the effect of the system BioRow Tech on a rowing ergometer for the perfection of the technique of novice rowers and whether the feedback they receive would help them master the correct movements.

RESEARCH METHODS

The system BioRowTech for ergometer provides the experts with detailed information about the contribution of the different elements to the total amplitude of the rowing cycle, values and curves of the velocities of the different segments, and so on. The system works with a modified BioRowTel software with Windows, which allows for recording the results, visualizing the mean curves and values, and analyzing the differences between different rowers and indicators. It measures three variables: the position of the handle, seat, and trunk (at the level of the shoulder joint). The velocities of the legs, trunk, and arms are recorded in the measured positions and

are used for analyses. The following three indicators provide the rower with information in real-time:

Catch Factor – the time difference between the instant of the handle changing direction and the instant of the seat changing direction at the catch.

Rowing Style Factor – the ratio of seat travel to the handle travel during the first 20% of the drive length.

Finish Factor – is the time difference between the instant of changing the direction of the trunk and changing the direction of the handle at the finish.

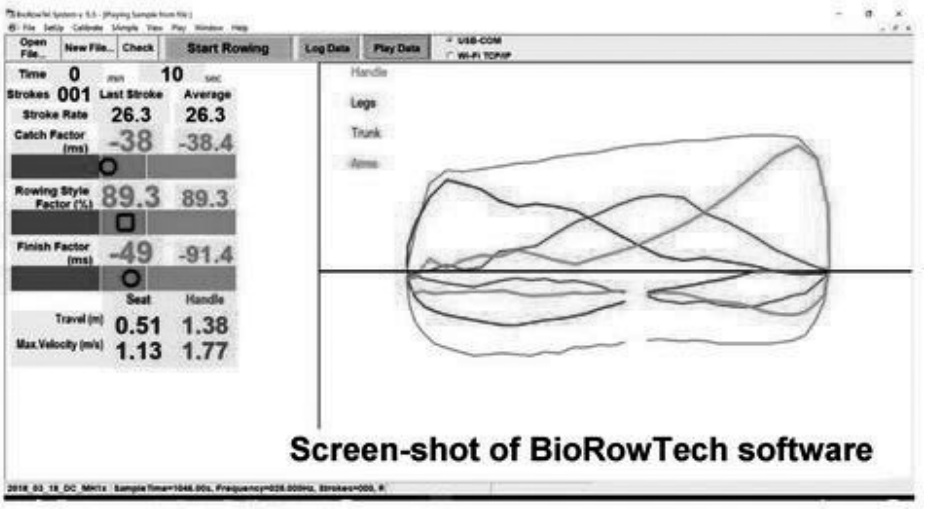

Figure 2. *Sample values of the three indicators (to the right) and their graphic expression (BioRowTech system for Ergometer (inc. handle force sensor))*

The three indicators explained above are presented in the figure, to the left. Four curves are presented to the right, these show the velocity of the legs, trunk (between the seat and the shoulders),

and arms, as well as the velocity of the handle, which is the sum of the other three velocities of the different segments. The curves are presented relative to the position of the handle along the x-axis so they make loops around the axes; where the drive phase is presented above the axis, and the recovery – is below it. The visual shape of the curves is complimentary to the indicators and may help to understand better the specifics of the rowing technique.

The research was done among 9 university students – novice rowers from the Technical University in Sofia. They were asked to make 10 cycles with a different rate - 20, 22, and 24 so that we could determine their starting level. The research was repeated after 3 months. In the meantime, the researched group trained twice a week on a rowing ergometer with the system BioRowTech during the rowing classes of the curriculum of the Technical University. The primary task in each training session was mastering the rowing technique.

Figure 3. *A training session with the system BioRow Tech*

After processing the recorded data from the research, we subjected them to statistical processing with the software product SPSS 19. The methods we used were variation analysis, correlation analysis, and analysis for establishing an increase in the data after a series of surveys.

RESULTS AND ANALYSIS

Table 1 presents the results of two of the researched individuals in the surveys (1 and 2). The three intensities (rates) are presented in different colors: rate 20 – in lilac, rate 22 – in red, and rate 24 – in green. For these two researched individuals, we can see an increase in the values of the three intensity rates in the second testing. There was an increase in the velocity indicators of the handle and the body segments, as well as in the three technical indicators which the system detects (catch factor, rowing style factor, and finish factor). The most significant improvement was observed in the rowing style factor, where the values from the second test were close to the optimal 90%. This shows improved coordination of the body segments and the predominance of leg work at the beginning of the working phase.

Table 1. *Results of two of the researched individuals*

								Force		Maximal Speed (m/s)			Avg.	Peak	
Sample ID	Stroke Rate (str/min)	Average Handle Velocity (m/s)	Max.Handle Velocity (m/s)	Catch Factor (ms)	Rowing Style Factor (%)	Finish Factor (ms)	Rowing Power (W)	Max. Force (N)	Average Handle Force (N)	Legs (m/s)	Trunk (m/s)	Arms (m/s)	Rowing Power (W)	Rowing Power (W)	Trial -1,2
S.S.	**18.4**	1.33	1.92	42.0	50.4%	2.4	207	859	409	1.06	0.65	1.32	207	1502	1
S.S.	**19.8**	1.47	1.98	14.8	67.0%	-18.2	220	923	543	1.09	0.67	1.39	229	1652	2
S.S.	**21.7**	1.42	1.99	44.4	45.3%	12.5	231	797	386	1.15	0.70	1.48	231	1407	1
S.S.	**22.3**	1.48	2.01	12.9	65.8%	-19.4	267	989	515	1.19	0.73	1.51	261	1687	2
S.S.	**23.4**	1.46	2.03	47.8	45.8%	0.6	252	822	390	1.19	0.73	1.49	252	1478	1
S.S.	**24.6**	1.49	2.07	12.7	65.9%	-20.7	287	992	586	1.22	0.76	1.55	279	1654	2
H.A.	**19.8**	0.90	1.21	5.8	98.8%	-47.2	62	287	122	1.01	0.80	1.00	62	317	1
H.A.	**18.4**	1.22	1.82	12.2	78.3%	6.1	168	926	376	1.14	0.92	1.25	168	1488	2
H.A.	**22.2**	1.02	1.36	5.9	97.1%	6.3	94	409	165	1.11	0.78	1.06	94	500	1
H.A.	**22.8**	1.33	1.92	10.8	76.0%	-8.9	208	985	368	1.36	1.06	1.40	208	1655	2
H.A.	**24.1**	1.08	1.47	3.1	93.5%	-33.1	111	460	183	1.18	0.74	1.15	111	614	1
H.A.	**24.6**	1.34	1.91	3.2	84.2%	-11.0	212	969	351	1.43	1.10	1.40	212	1647	2

Table 2 *Mean values of the indicators of the researched individuals and the increase in the three intensity rates*

								Force		Maximal Speed (m/s)			Avg.	Peak
	Stroke Rate (str/min)	Average Handle Velocity (m/s)	Max.Handle Velocity (m/s)	Catch Factor (ms)	Rowing Style Factor (%)	Finish Factor (ms)	Rowing Power (W)	Max. Force (N)	Average Handle Force (N)	Legs (m/s)	Trunk (m/s)	Arms (m/s)	Rowing Power (W)	Rowing Power (W)
Rate 20														
Avg Trial 1	19.3	1.1	1.5	14.3	71.6%	-56.4	131.4	559.0	255.4	1.0	0.7	1.1	132.8	787.5
Avg Trial 2	19.7	1.3	1.8	15.0	86.0%	-33.2	173.4	807.3	334.5	1.2	0.9	1.3	173.4	1281.5
	0.4	0.2	0.3	0.8	14.4%	23.2	42.0	248.3	79.1	0.3	0.3	0.2	40.5	494.1
Rate 22														
Avg Trial 1	21.886	1.2205	1.7028	13.414	71.2%	-50.94	175.87	671.53	295.47	1.131	0.7877	1.2992	175.41	1017.1
Avg Trial 2	22.403	1.3518	1.9119	7.8641	86.7%	-46.07	203.8	852.09	340.04	1.3538	1.0681	1.4739	203.8	1417.9
	0.517	0.1313	0.2091	-5.55	15.5%	4.8763	27.938	180.56	44.569	0.2228	0.2804	0.1747	28.393	400.88
Rate 24														
Avg Trial 1	24.334	1.3332	1.8451	10.078	70.4%	-57.61	221.5	764.37	336.2	1.2485	0.9071	1.4428	220.6	1243.8
Avg Trial 2	23.958	1.3815	1.933	4.2619	89.7%	-64.34	214.21	850.79	335.93	1.4023	1.1333	1.5546	214.21	1274.5
	-0.376	0.0484	0.0879	-5.816	19.3%	-6.73	-7.296	86.417	-0.27	0.1538	0.2261	0.1118	-6.387	30.699

Table 2 shows the mean values from the two tests (1 and 2) of all researched individuals and the three intensity rates; the difference was also calculated. There was an increase in the results from the second test in the velocity indicators of the handle and the body segments (legs, trunk, and arms), as well as in the three technical indicators in the lower rowing rate (20 and 22). There was a small or no increase in rate 24. We believe this is due to the still not automatized movements whose coordination was disrupted by the higher rowing rate.

There was a most significant average increase in the rowing style factor d% = 23.3%, P(t) = 0.430, and values close to the optimal value of 90% in the three intensity rates, which shows that despite the relatively short period for mastering the technique, the researched individuals improved their coordination of changing the direction of the handle and the impact of the legs in the drive phase.

There was no improvement in the catch factor, where the optimal value was -25м/s and the mean values of the researched individuals decreased in the second test. The mean values of the increase between the surveys were d% = -75.17%, P(t)= 0.134. This shows that the researched individuals began early with the trunk at the beginning of the drive phase. There was also a performance depreciation in the absolute values of this technical indicator.

As for the finish factor, there were better values for rates 20 and 22 and deterioration in the values in rate 24, which, in our opinion, was due to insufficient training time. The increase of this indicator was d% = 33.86%, P(t) = 0.317, which confirms that the technical execution of this indicator improved through a decrease in the time needed for the performance of the movement. There was an increase in the indicators of strength and power – both in the mean values and the maximal values, although the training sessions were aimed at mastering the rowing technique, not at developing the physical qualities. In our opinion, this is due to the use of the BioRowTech system and the feedback it provides for each rowing cycle performed, which makes the rower follow the curve model and seek better performance in every stroke – thus increasing the power in the drive phase. `

When we observe the parameters along their intensity (rowing rate), we can see an improvement in the parameters in the rate of 20st/min. If we increase the rate to 22 st/min, most parameters are positively influenced during the training process. We cannot apply this to the parameters at an intensity rate of 24st/min. At this intensity rate, most of them show a negative increase. We can conclude that the movement has not turned into a motor habit, and the increase in the stroke rate deteriorates the technical execution.

CONCLUSION

Based on the obtained results and the analysis, we can summarize that the effect of the use of the BioRow Tech system for mastering the rowing technique is a positive one. Despite the relatively short period of one academic semester and the small number of classes, there is an improvement in the technical indicators at a lower intensity rowing rate. We recommend using the system BioRow Tech on an ergometer for mastering the rowing technique. We think the feedback it provides is essential for learning the correct rowing movements and could cut down the time novice rowers typically need to improve their rowing technique.

REFERENCES

Altenburg, D. et al. (2012). *Manual for Rowing Training*, Limpert Verlag GmbH, Wiebelsheim

BioRowTech system for Ergometer (inc.. handle force sensor). Biorow. (n.d.). Retrieved October 2, 2022, from http://biorow.com/index.php?route=product%2Fproduct&path=61_108&product_id=60

BioRowTech system for rowing ergometer. Biorow. (n.d.). Retrieved October 2, 2022, from http://biorow.com/index.php?route=product%2Fproduct&path=61_108&product_id=55

Herberger, E., et al. (1983). *Rowing*, Sport Books Publisher, Toronto

Hristov, R. (2015). *Grebane*, NSA PRES, Sofia

Hristov, R. (2015). *Technika na grebaneto razvitie i savremenni aspekti*, Bolid INS, Sofia

Kleshnev, V. (2020). *Biomechanics of Rowing*, The Crowood Press Ltd., UK

Nilsen, T., et al (2004) *Be a Coach*, FISA, Lausanne

Nolte. V. (2005). *Rowing Faster*, Human Kinetics, UK

Secher, N. and Voliantis, S. (2007). *Rowing*, Blackwell Publishing, USA

Thompson, P. (2005). *Sculling*, The Crowood Press Ltd., UK

Tosheva, M. (1981). *Obuchenie po grebane*, ECNPKFKS, Sofia

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ROLE OF AUXILIARY APPARATUS WHEN STUDYING A KIP OF THE UNEVEN BARS

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ABSTRACT

The trends and development of artistic gymnastics have required the complication of the competitive combinations in individual apparatus. This has led to the need to improve the technique of basic exercises with the help of auxiliary apparatus in artistic gymnastics. The aim present study is to establish the role of auxiliary apparatuses in the study a kip of uneven bars. The ten best performances were selected through expert evaluation. Using frame-by-frame motion analysis, we measured the angles in the different phases of the impact of the exercise. The object of the study is the technique of the basic exercises of the uneven bars, and the subject is the need for auxiliary apparatuses in practice. To achieve this aim, we used the methods of expert evaluation, biomechanical analysis, and mathematical-statistical methods – variation analysis. The analysis shows that the average value of the angle in the hip joints in the preparatory phase and in the main information closes to or decreases with the angle when performing the exercise of the auxiliary apparatuses – a ball in the preparatory phase; per cylinder – in the main phase; on a simulator – also in the main phase. At the angle in the shoulder joints, both the coincidences and the differences in the individual parts when performing a kip. The results for angles that do not coincide with the angles of the auxiliary apparatuses are considered. We don't know whether the auxiliary apparatus will give the necessary effect in learning the correct technique when performing a kip. In conclusion, we can summarize that the obtained data will help specialists in gymnastics to study the technique of basic exercises of individual apparatuses in artistic gymnastics in adolescent gymnasts.

Keywords: *artistic gymnastics, auxiliary apparatuses, technique*

INTRODUCTION

Increasing the sport and technical capabilities of gymnasts is possible when creating the necessary prerequisites for this. One of these prerequisites is the selection of special preparatory exercises that will directly assist in the training of both basic motor habits and skills and complex ones. This preparation prioritizes the search for an innovative approach to the correct, easy, and quick learning, consolidation, and improvement of gymnastic exercises. Technical training is a part of overall sports training and constitutes a purposeful process of learning and improving gymnastic exercises under the guidance of a coach (Davidov, Krumova-Tsoncheva, Petkovic, 2017).

There is a great development nowadays regarding the equipment for practicing artistic gymnastics to which the auxiliary apparatuses are an inseparable part. In modern and contemporary gymnastics, there is well-defined auxiliary equipment to each gymnastic apparatus, which are widely used in practice. Auxiliary apparatuses are also used to develop different physical qualities, flexibility, agility, coordination, etc. Exercises on gymnastic apparatuses are related to the most complex movements of the human body. They are diverse in form, coordination, and mechanism of execution. That is why gymnastics specialists strive to study more fully the technical structure of exercises (Gaverdovsky, 1963). When optimizing the preparation using uneven bars the need arises for a more effective approach to the work of physical training and in particular for special physical training. It will help mastering the sports technique and sports improvement (Petrova, 2020).

Uneven bars are one of the most attractive apparatuses in women's gymnastics with a large volume of exercises of varying degrees of difficulty. One of the basic exercises in artistic gymnastics is the kip. It can be performed on different apparatuses in women's and men's gymnastics – uneven bars, horizontal bars, parallel bars, and rings. The exercise is performed by beginners and elite gymnasts depending on their training and competition program (Arkaev, Suchilin, 2004). A kip is an exercise that serves as a transition from one motor action to another. It is a connecting link for different combinations and connections when performing routines on uneven bars (Aceskii, Spasovska, 2019). The exercise has different variations, but in this research

paper, we are focused on the performance of the kip on the low bar of uneven bars.

To support the work of coaches and specialists, it is important to analyze exercises in detail.

Therefore, the aim of our study is to establish the role of auxiliary apparatuses in learning the kip on uneven bars. To achieve this aim, we set ourselves the following tasks:

1. To conduct videotaping of specially kip preparatory exercises performed on auxiliary apparatuses.
2. To make a biomechanical analysis of the kip and of the special kip preparatory exercises.
3. To conduct a comparative analysis of the results obtained (shoulder and hip joints) on uneven bars and auxiliary apparatuses.

The object of the study is the technique of basic exercises on uneven bars, and the subject is the need for auxiliary equipment in practice. The study contingent consisted of 10 female gymnasts aged 7-9 years.

METHODOLOGY

Measurements and indicators

Expert evaluation determined the 10 best performances of the kip on uneven bars from the 2014 European Artistic Gymnastics Championship in Sofia. Hip and shoulder joint angles were measured in the different phases of the exercise performance using frame-by-frame motion analysis (Kinovea). A still video camera (30fps; Iphone13-Ultra wide 12 MP HD camera) was used to record the exercises performed using auxiliary apparatuses, which corresponded to the main phases of the technique during the execution of the kip. We measured the hip and shoulder joint angles when using the auxiliary devices and compared them with those during the overall exercise performance.

Research Methods

To achieve the aim and tasks of the study, we used the methods of *specialized literature survey, expert evaluation, biomechanical analysis, mathematical-statistical methods – variation analysis*.

Procedure

The study was carried out in April-May 2022 with gymnasts from SC "A-GIM" in the gym of NSA "Vasil Levski" in Sofia. We studied 10 female gymnasts aged 7-9 years. All children participated voluntarily in the study with parental informed consent. Before performing each special preparatory exercise using the auxiliary apparatuses, a demonstration was made and the technique was explained in detail. A ball (25cm), a cylinder, a training aid 1 (in the main phase), and a training aid 2 (in the final phase) were used to perform the kip.

Data Analysis

The results of the study were subjected to mathematical-statistical processing using SPSS 26. Depending on the tasks of the study, the following methods were applied: *motion analysis software Kinovea* – to determine the angles in the joint units and *variation analysis* – to determine the mean values, normality of distribution, and variability of the studied indicators (Gigova, 2009).

RESULTS

The biomechanical analysis is important to quantify the exercise parameters, thus determining the factors that are critical for successful learning of the kip. For easier analysis of the movements, depending on their structure, the kip is divided into four parts (Aceskii, Spasovska, 2019, Heinen, et al., 2013) (Figure 1).

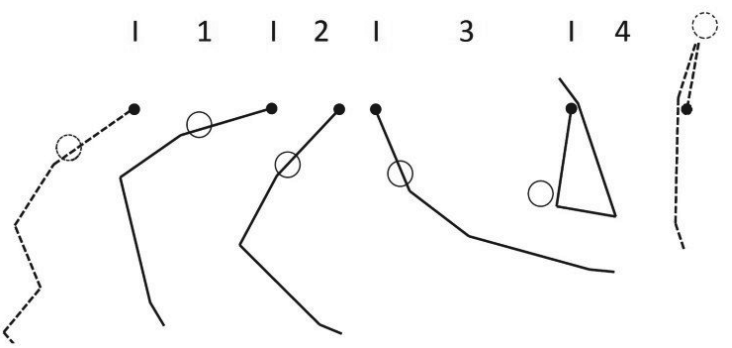

Figure 1. *Kip phases*

- **Part one** (preparatory phase 1) – starts immediately after the feet are off the floor and ends when the gymnast's center of gravity reaches maximum height.
- **Part two** (preparatory phase 2) – lasts from the moment of initiation of the angular swing to the full unfolding at the hip joints.
- **Part three** (main phase) – is when the legs begin to move upward and backward toward the low bar, beginning with a vigorous folding at the hip joints and continuing until the gymnast's feet reach the bar.
- **Part four** (final phase) –starts from the moment of unfolding the hip joints and pulling with the hands until reaching the final support position on the low bar.

Table 1 presents the variation analysis of hip joint angles when performing a kip.

Table 1. *Variation analysis of hip joint angles during kip execution*

Indicator	n	Mean	min	max	R	S	V%	As	Ex
Preparatory phase 2	10	**163.00**	158.50	169.10	10.60	3.81	14.48	0.469	-1.131
Main phase	10	**64.28**	57.70	70.40	12.70	3.85	14.82	-0.098	-0.574
Final phase	10	**135.39**	129.40	139.40	10.00	3.56	12.68	-0.446	-1.096

The analysis of the results shows that for all indicators the group is approximately homogeneous – the coefficient of variation is over 12%. In terms of asymmetry (As) and excess (Ex), the distribution of values is normal. The mean value of the angle at the maximum hip unfolding in the second part of the preparatory phase was 163 degrees, compared to the same phase with the ball auxiliary equipment, the angle was 151.8 degrees (Figure 2). This indicates that this auxiliary apparatus will be suitable for learning of the kip.

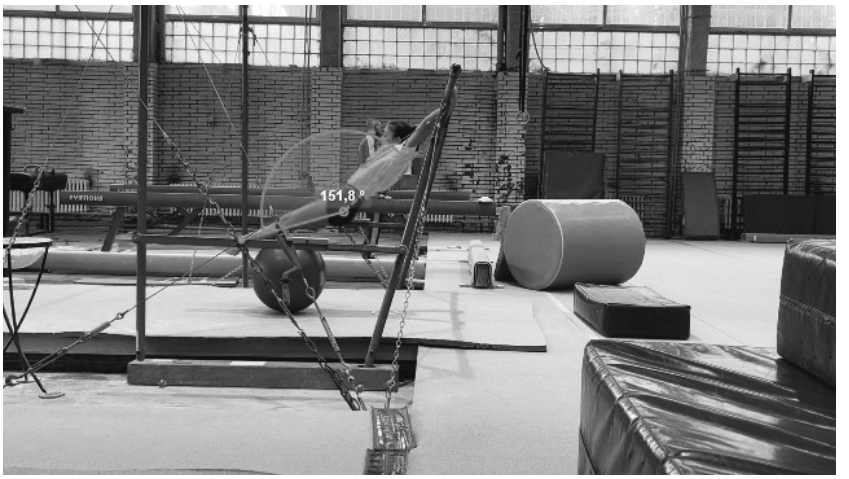

Figure 2. *Angle at the hip joints with an auxiliary equipment ball*

The values in the main phase were also similar when performing the kip with the equipment cylinder – 66.1 degrees (Figure 3); training aid 1 – 74.7 degrees (Figure 4) with mean values at the moment of maximum hip folding of 64.28 degrees.

Figure 3. *Angle at the hip joints with an auxiliary equipment cylinder*

Figure 4. *Angle at the hip joints with auxiliary equipment – training aid 1*

In the final phase of the kip performance, there is a match with the auxiliary trainer 2. The mean value at the hip joints was 135.39 degrees, and 136.0 degrees for training aid 2 (Figure 5).

Figure 5. *Angle at the hip joints with auxiliary equipment – training aid 2*

Table 2 presents the variation analysis of shoulder joint angles in different phases of the exercise. For the angles in the shoulder joints, there were both matches and differences during the performance of the kip.

Table 2. *Variation analysis of shoulder joint angles during kip execution.*

Indicator	n	Mean	min	max	R	S	V%	As	Ex
Preparatory phase 2	10	**170.44**	163.20	175.40	12.20	4.36	19.02	-0.475	-1.377
Main phase	10	**90.44**	82.20	97.20	15.00	4.86	23.65	-0.162	-1.052
Final phase	10	**25.29**	18.10	33.30	15.20	5.39	29.04	0.007	-1.427

In both the hip and shoulder joints, the analysis showed that the group was approximately homogeneous, with a V between 19.02% and 29.04%. In the preparatory and main phases, angle matches were observed in the shoulder joints with the equipment ball – 169.2 degrees, with a mean of 170.44 degrees (preparatory phase); cylinder – 99.2 degrees, and support stick – 98.3 degrees (main phase). This is not the case for the angles in the main phase for the training aid 1. The average value in the execution of the kip is 90.44 degrees and in training aid 1 – 66.8 degrees (Figure 6).

Figure 6. *Angle at the shoulder joints with auxiliary equipment – training aid 1*

Differences are also visible in the final phase. The angle at the shoulder joints in the auxiliary equipment training aid 2 is 60.4 degrees (Figure 7), while the mean value is 25.29 degrees at the moment when the shoulders are horizontal behind the bar.

Figure 7. *Angle at the shoulder joints with auxiliary equipment – training aid 2*

DISCUSSION

Increasing the sport and technical capabilities of gymnasts is possible when creating the necessary prerequisites for this. One of these prerequisites is the selection of special preparatory exercises that will directly assist in the training of both basic motor habits and skills and complex ones (Davidov, Krumova - Tsoncheva, Petkovic, 2017).

The analysis clearly shows that most of the special kip preparatory exercises on the auxiliary apparatuses that we have studied coincide with the angles of three of the phases in the overall exercise performance. The analysis of the use of the auxiliary equipment training aid 2, in the final phase, is debatable. It showed a difference of 35.11 degrees at the shoulder joints. Therefore, we believe that training aid 2 would be more appropriate for the main phase when learning the kip. Very often, coaches' resort to auxiliary equipment, as this allows them to emphasize the basics of the learned exercise, so that the children can perform the whole exercise as quickly and easily as possible (Bozhinova, Dimitrova, 2021).

From the study, we have established that the values of hip and shoulder joint angles in the preparatory and main phases of the kip are similar to those during the performance with auxiliary apparatuses. To improve technique in the final phase of kip execution, it is necessary to look for a new approach related to more effective special preparatory exercises. The data obtained in this study can help coaches and specialists in training adolescent gymnasts.

REFERENCES

Aceskii, A., Spasovska, K. (2019). The kinematic differences in the glide kip on horizontal bar between the elite gymnast and students. *European journal of physical education and sport Science*, Vol. 5, issue 3

Arkaev, L.I., Suchilin, N.G. (2004). *How to create champions. The theory and methodology of training topclass gymnasts*. Oxford, Meyer & Meyer Sport

Bozhinova, I., Dimitrova, B. (2021). Rolya na spomagatelnite uredi v praktikata na vodeshti spetsialisti v Bulgaria po sportna gimnastika. *Godishnik na NSA „Vasil Levski"*, Tom 2, NSA PRES, Sofia

Gaverdovskiy, Yu.K. (1963). *Metodika analiza tehniki gimnasticheskih uprazhneniy.* Teoria i praktika fiz. kulytury, №2

Gigova, V. (2009). *Statisticheski metodi vav fizicheskoto vazpitanie.* Uchebni zapiski za studenti ot Magistarska stepen na NSA. Sofia

Davidov, D., Krumova-Tzoncheva, K., Petkovich, E. (2017). Prilojenieto na ureda Rokin Gym v tehnicheskata podgotovka na podrastvashti gimnastichki. *Sbornik dokladi ot godishna universitetska nauchna konferencia* 1-2 iuni 2017.Tom 1, p.175-180, Veliko Turnovo

Heinen, T., Apitius, K., Mirzaie, F. (2013). Movement regulation of the glide kip in gymnastics. *Sport Science*, 6(1), pp. 82-86

Petrova, M. (2020). *Smesena usporedka, spetsialna fizicheska podgotovka*. Monografia. NSA PRES

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INVESTIGATION OF THE SPEED OF THE INDIVIDUAL MOVEMENT AND THE SPECIFIC MOTOR REACTION IN TAEKWONDO

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ABSTRACT
Taekwondo WT is a complex Olympic sport and a martial art. As such, the reaction time and the speed of the individual movement are of great importance. Our study aimed to establish values in terms of the specific reaction time and the speed of the individual movement in two taekwondo kicks. Twelve active taekwondo athletes took part in the study. We measured the speed of the single movement for two taekwondo kicks and also the time for inflicting those two kicks using KICK.AI ankle bracelets and software. The variation analysis we applied on dollyo chagi showed an average execution speed of 5.53 m/s for the right leg and 5.51 m/s for the left. For dollyo chagi with the front leg, the corresponding mean values were 4.64 m/s for the right and 4.08 m/s for the left leg, respectively. The specific reaction time for those two kicks required the subjects to perform the kicks after a signal from the software, which measured the time from giving the audio signal to the impact on the target. The time required to apply the dollyo chagi with the right leg was 785.70 ms, while the average values for the left were 781.65 ms. The specific reaction time for the front leg dollyo chagi was 788.25 ms for the right and 767.49 ms for the left. After processing the results, we came to the conclusion that it is necessary to establish the relationship between the speed of the individual movement, height of the subject, weight category, and length of the lower limb. We found that the dominant leg affects the guard with which an athlete competes. Such tests can be used not only for quality control of speed but also as a psychological training. Some of the data obtained lead us to believe that the KickAI device must be subjected to a thorough technical analysis to prove its objectivity. We recommend further study into the influence between the technique of execution, the speed, and the force of the kick.

Keywords: *taekwondo, speed, reaction time, kick*

INTRODUCTION

Taekwondo WT is a complex Olympic sport and a martial art. As such, the reaction time and the speed of the individual movement are of great importance. The aim of our study is to establish values in terms of the specific reaction time and the speed of the individual movement in two taekwondo kicks. Twelve active taekwondo athletes took part in the study. We measured the speed of the single movement for two taekwondo kicks and also the time for inflicting those two kicks using KICK.AI ankle bracelets and software.

The authors consider it necessary to determine specific values for the main physical qualities needed to achieve success in taekwondo. This will facilitate the evaluation of the training process, could present a standardized physical assessment, and could help in the selection of taekwondo athletes.

Aim and objectives of the study

The aim of the study was to determine values in regard to the speed reaction time and the speed of particular movement in three taekwondo kicks.

Since taekwondo matches involve intermittent interval activity consisting of maximum speed and power exertions alternating with periods of low intensity movements, we hypothesized that the reaction time and the speed of the particular movement will be an important success factor in taekwondo. The reaction time and the speed of the single motion are with highest importance in taekwondo. Even in the non-Olympic discipline of the WT Taekwondo – poomsae or form, speed is one the attributes that are being scored by the judges (WT, Even though there have been several attempts to measure speed reaction time with standard tests Vieten et al., (2007) and Asia (2013), and even researches on the effect of caffeine over taekwondo performance in terms of reaction time have been made Victor et al. (2014), but specific taekwondo test are not available to the ordinary practitioner.

METHODS

Subjects

14 taekwondo players, all male, aged 15 to 22, voluntarily took part in the study. Each athlete or athlete's parent in the case of an athlete under 18 years of age signed an informed consent form before participation in the study. Ethical clearance was obtained from the Bulgarian Taekwondo Federation. All of the participants were active athletes with more than 7 years of experience in taekwondo.

Testing procedures

Subjects performed a self-paced warm-up for approximately 20 minutes. KICK.AI ankle bands were placed around the ankles immediately before the execution of the kicks, which were performed on a hard object (a punching bag), with the height of the kick being the height of the belly button of each of the subjects. First, the speed of the individual movement was examined, and the subjects performed 3 trial kicks followed by 5 kicks per leg, which were recorded. After completion of all kicks, we moved on to lower extremity reaction speed testing. It consisted of measuring the time of execution of 5 kicks, which were delivered after to a signal automatically given by the software.

Statistical analysis

All statistical analyses were calculated by the SPSS statistical package. The results are reported as means, minimum and maximum values.

RESULTS

Speed is the ability to execute motions with a maximum speed (Jeliazkov et al., 2020) and is a part of the fundamental five types of physical qualities (Hadzhiev et al, 2011).

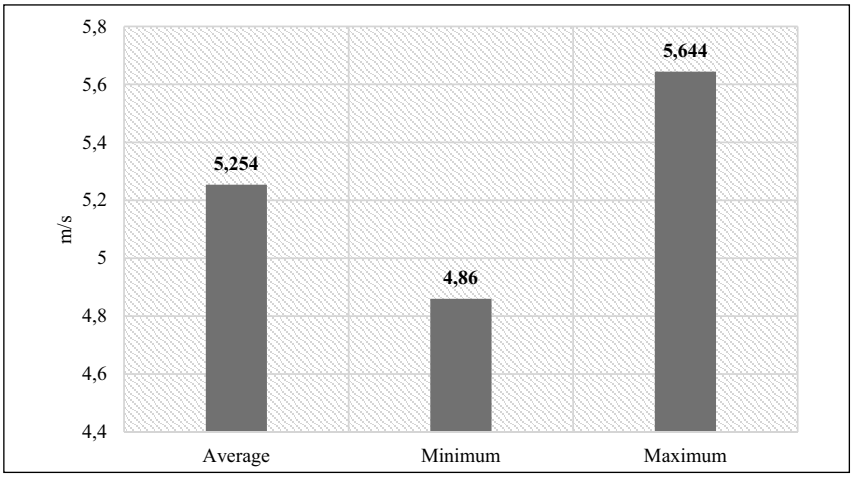

Figure 1. *Velocity of rear right leg dollyo chaggi*

The average value of all the attempts is 5.254 m/s with a minimum average value of 4.86 m/s and a maximum average value of 5.644 m/s. Dolo Chagig is one of the most used techniques in competitive Taekwondo. Through the periods that Taekwondo goes through, this technique does not lose its importance and continues to be highly effective.

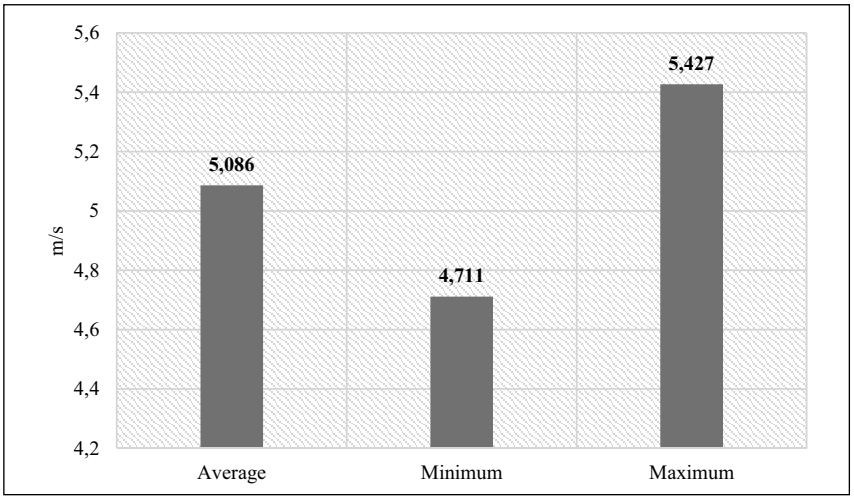

Figure 2. *Velocity of rear left leg dollyo chaggi*

A slight drop in the subjects' results was observed with the left rear dollo chaggi rear, which suggests that it was their right leg that was more comfortable and faster for most of the subjects. The average of all execution is 5.086 m/s, the minimum average is 4.711 m/s, and the maximum average is 5.427 m/s.

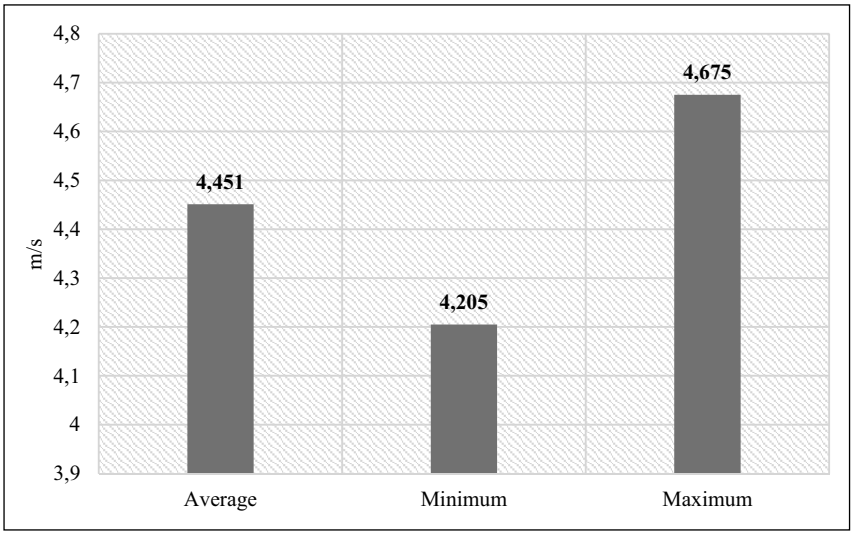

Figure 3. *Velocity of front right leg dollyo chaggi*

Although the time needed for reaching the target with the front leg is shorter than the time to reach the target of the rear leg, the speed that the back leg develops is higher than the front leg. Since the front leg is closer to the target than the rear leg, obviously latter leg has more time to develop a higher speed. The subjects' average was 4.451 m/s, the maximum average speed was 4.675 m/s, and the minimum average was 4.205 m/s. From the tests done so far, we have noticed the superiority of shorter taekwondo players who are significantly faster than taller ones.

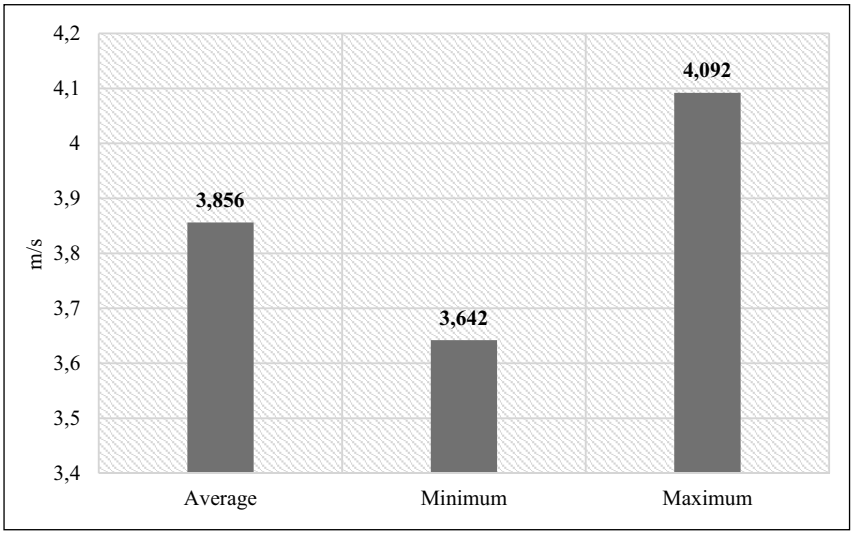

Figure 4. *Velocity of front left leg dollyo chaggi*

Our theory of a slower left leg is confirmed here as well, with the majority of test subjects registering lower values with the left foot. The mean for this technique is 3.856 m/s, which is more than 0.5 m/s difference than the right one. The average minimum is 3.642 m/s and the average maximum is 4.092. For all three values, the left and right leg differences are significant, which confirms our statement that the majority of the examined individuals have a better-developed right leg.

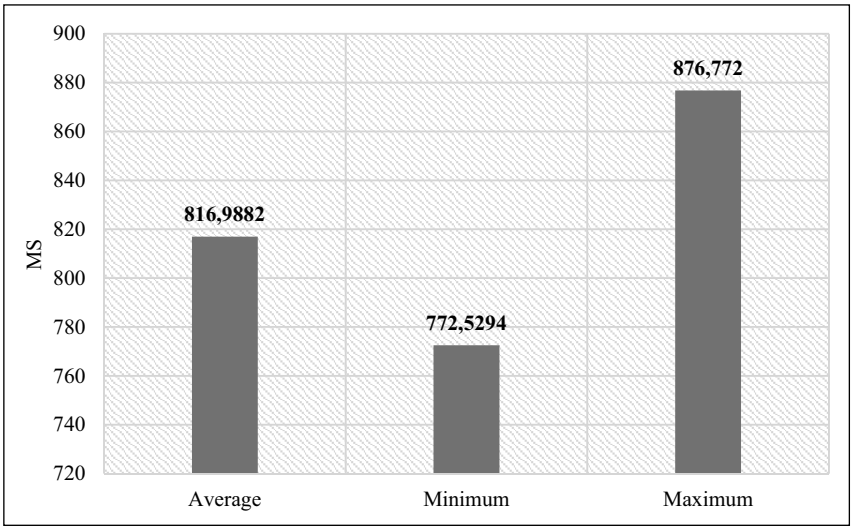

Figure 5. *Reaction time for rear right leg dollyo chaggi*

In the speed of the reaction test, shorter taekwondo players again performed better, with their legs traveling a shorter distance to hit the target than taller taekwondo players. This suggests that attention should be paid to the ratio of height to length of a lower limb and how they affect the speed in Taekwondo in general. The average speed registered here is 816.98 MS, the minimum average time is 772.5294 MS, and the maximum average time is 876.772 MS. During a sparring match, the reaction is of the utmost importance, sometimes a hundredth can decide the winner of the match, especially when it comes to elite athletes of equally technical and tactical ability.

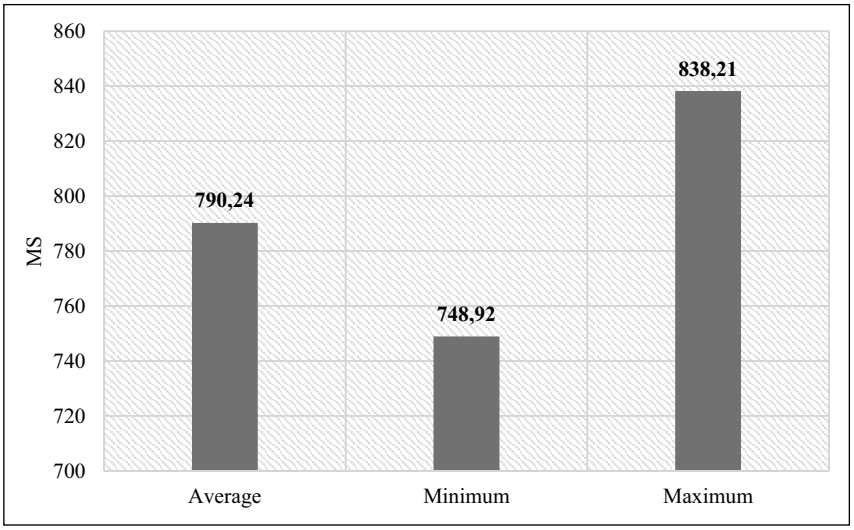

Figure 6. *Reaction time for rear left leg dollyo chaggi*

Very interesting results are obtained with the rear left leg dollyo chagi, where the left leg dominates the right. The average value achieved by subjects was 790.24 ms, the minimum average time was 748.92 ms, and the maximum average time was 838.21 ms.

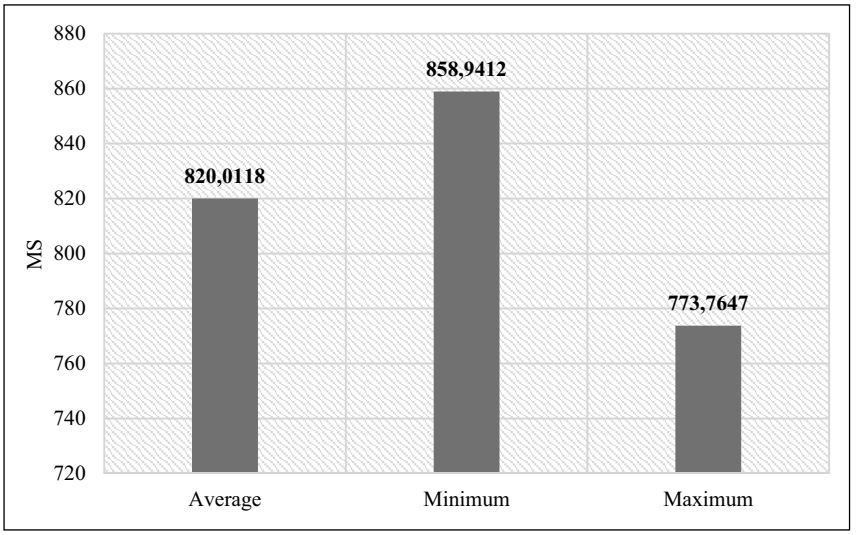

Figure 7. *Reaction time for front right leg dollyo chaggi*

The results obtained from the study of the reaction time of the right front leg dollyo chagi are very close to those of the right rear leg, and here the subjects even lowered the limit of the average minimum value. The front leg travels significantly less distance than the rear leg and we expected it to perform much better than it did. The average of those tested was 820.0118 MS, the minimum average time was 773.7647 MS, and the maximum average time was 858.9412 MS. This technique is often used by modern Taekwondo fighters, especially in a counterattack when they react to an opponent's strike.

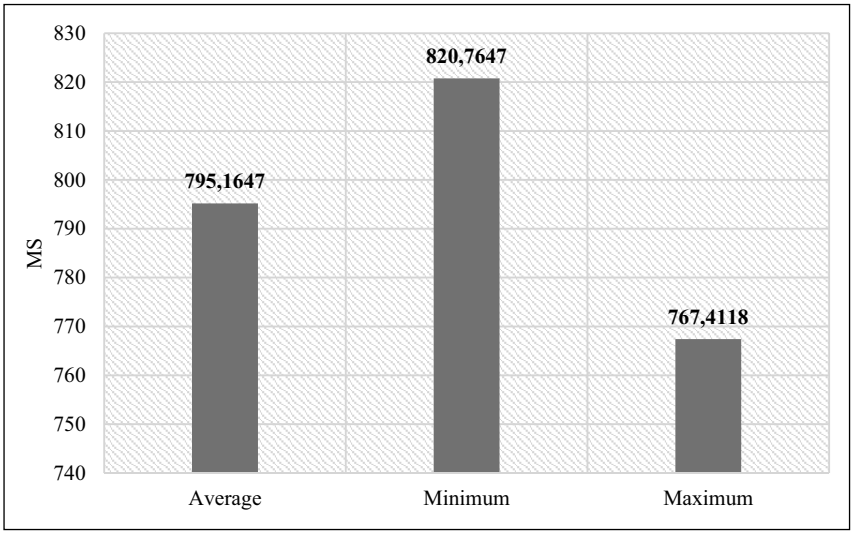

Figure 8. *Reaction time for front left leg dollyo chaggi*

Interestingly enough, the subjects scored better values with the left leg. Furthermore, the left leg was reported as inconvenient by the majority if the subjects. The average is 795.16 ms, the average minimum time is 767.41 ms, and the average maximum is 820.76 ms.

DISCUSSION

In the course of the research, some of the results we obtained did not meet our expectations in terms of the level of competitors and the corresponding results shown. We recommend that in the future the relationship between the speed of the individual movement, the height of the examined person, weight category, and the length of the lower limb should also be determined. Some of the results we acquired suggest further testing of the KickAi device.

In the course of the testing, some of the results did not correspond with the athlete feeling about the

preferred and more comfortable leg. It turned out in some cases that even though the athlete felt more confident kicking with one of his legs, it was the other leg that showed better results. Unlike boxing, every taekwondo athlete is trained to use two stances – southpaw and orthodox, but in the course of his career usually, they tend to stick mainly to one of them. This type of conclusion, back by technical data can boost an athlete's confidence and enhance his technique arsenal.

We recommend coaches periodically use this kind of tests, as they provide feedback regarding the applied methodology and have a stimulating effect on the nervous system. Further research should be conducted on other Taekwondo kicks as well so that a scoring chart can be built to track the progress of the athlete. Further research should be conducted to determine the correlation between the technique of execution, speed and power of the kick, as we have reason to believe that the individual technique of the competitors plays an important role in the execution of the kick

REFERENCES

Asia, A. A., Warkar, A. B. (2013). Auditory and visual reaction time in taekwondo players. *International Journal of Recent Trends in Science And Technology, 8*(3), 176-177.

Hadjiev, N., Andonov, K., Dobrev, D., & Petrov, V. (2011). *Fizicheska podgotovka v gimnastikata.* Sofia: NSA press.

Jelyazkov, T., Dasheva, D., & Neykov, S. (2020). *Osnovi na sportnata trenirovka.* Sofia: NSA

Santos, V. G., Santos, V. R., Felippe, L. J., Almeida, J.W., Bertuzzi, R., Kiss, M. A., & Lima-Silva, A. E. (2014). *Caffeine Reduces Reaction Time and Improves Performance in Simulated-Contest of Taekwondo.* doi:10.3390/nu6020637

Vieten, M., Scholz, M., Kilani, H., & Kohloeffel, M. (2007). *Reaction time in taekwondo*. Retrieved 2022, from Academia Edu: https://www.academia.edu/3223845/Reaction_time_in_Taekwondo

World Taekwondo Federation (2022). *Poomsae competition rules and interpretation.* Retrieved 2022, from www.worldtaekwondo.org: http://www.worldtaekwondo.org/viewer_pdf/external/pdfjs-2.1.266-dist/web/viewer.html?file=http://www.worldtaekwondo.org/wp-content/uploads/2019/06/Poomsae_Competition_Rules_and_Interpretation_In_force_as_of_May_14_2019.pdf

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ANALYSIS OF ANTHROPOMETRIC STATUS AND SPECIFIC WORKABILITY OF THE YOUNGER NATIONAL HANDBALL TEAM UP TO 18 YEARS OLD

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ABSTRACT
Picking out and selection are the most essential elements of the multistructural system of sports training. With their help, a clear assessment is obtained, which determines the genetic talents of the athletes, who are directly dependent on the discovery of their game potential and the achievement of high sports results. That is why we set ourselves the goal to optimize the process of sports orientation and selection in handball, by revealing the peculiarities of physical development and their specific training. 22 handball players aged 17-18 from the youth national team of Bulgaria at a training camp in the town of Gabrovo were studied. Competitors passed sports and pedagogical testing on 12 indicators, of which 6 for anthropometry and 6 for sports and technical training. The data was statistically processed with the program SPSS 21, variation analysis was applied. For handball, anthropometric indicators of height, weight, and limb length are essential. Based on the research, we can say that there is potential in the selection of young handball players. In sports practice, good knowledge of physical development and motor skills allows sports professionals to properly and accurately plan and implement the training process over time.

Keywords: *handball, variability, anthropometric indicators, specific fitness*

INTRODUCTION

An important component of the sports training system, which is related to the training and training process, is the selection of adolescent handball players. It is built on the basis of genotypic and phenotypic factors.

In modern conditions of high competition, it is difficult to count on success without an effective sub-system for sports selection, which has good opportunities for natural or specialized selection of adolescents.

With the help of selection and selection, a clear assessment is obtained, determining the genetic predisposition of the competitors, which are directly dependent on revealing their playing potential and achieving high sports results. That's why we set ourselves the goal of optimizing the selection of players from the junior national handball team up to 18 years of age, by revealing the features of physical development and their specific training.

The coach's ability to select, measure, and objectively assess the condition of future handball players, predict their development, as well as to apply the right training tools and methods is particularly important for the successful management of the training process.

The training process places extremely high demands on young handball players in terms of their motor and functional capabilities.
The modern model of elite handball players is characterized not only by a high level of physical training but also by perfect mastery of the basic technical skills to the point of virtuosity. This, in turn, allows players to optimally realize their gaming potential.

Studies by a number of sports specialists (Avramova, 2020, Asparuhov, 2020, Borukova, Peykov, 2020, Chanev, 2013, Antonova, 2015, Varbanov, 2015, Chanev, 2013, Yotov, 2011) and others. are related to the development of individual physical qualities and optimal age periods.

METHODS

The purpose of the present study is to optimize the selection of the players from the junior national handball team up to 18 years of age, by revealing the features of physical development and their specific preparation.

The present study was conducted in the period of March 2022.
The research subject is the physical development and the specific working capacity of adolescent handball players.

The research object is the main signs of physical and technical-tactical preparation in handball.

Twenty-two handball players included in the expanded composition of the national team of Bulgaria for juniors, born in 2004-2005, were studied.

Table 1. *List of indicators*

№	Anthropometric ndicators	Metrics \ Parameters	Accuracy of measurement	Direction of increase
1.	Height	centimeters	0,1	+
2.	Weight	kilograms	0,1	+
3.	A wave of arms	centimeters	0,1	+
4.	Shoulder width	centimeters	0,1	+
5.	Lower limb length	centimeters	0,1	+
6.	Span length	centimeters	0,1	+
7.	10x15 м	seconds	0,01	-
8.	Standing long jump	centimeters	1,0	+
9	Smooth running 20 m	seconds	0,01	-
10	Handball throw	centimeters	0,01	+
11	Defensive move	seconds	0,01	-
12	Throwing a ball 3kg.	centimeters	1,0	+

For the needs of the study, all handball players were tested according to the 12 indicators (Table 1).

To realize the set goals and tasks, the following research methods have been applied:

- research of specialized literature
- anthropometry
- sports-pedagogical testing

The research results were subjected to mathematical and statistical processing with the SPSS 23 program, and a variational analysis was applied.

RESULTS

In the handball game, motor activity is manifested in the form of motor actions of different structures and forms. Their successful implementation in practical activity depends on the level of mastery of technical skills, as well as on special physical qualities, which in their essence manifest as exercises performed with different power.

That is why the study of physical development and specific motor skills and qualities will create real prerequisites for optimizing the motor activity of adolescent handball players, as well as improving selection.
Selection problems in handball can be solved more successfully by applying control theory. According to J. Broglie (1992), control covers the following three functions of management:

- Measurement
- Assessment
- Optimization

From a control theory perspective, the evaluation subsystem acts as an intermediary between the other two subsystems, thereby supporting strategic decision-making in both selection and training management.

In our case, the measurement of the different body segments of the handball players gives us information about the somatometric and some physiometric signs. The sports-pedagogical tests used are of high statistical reliability, and through them, we determine the level of motor training of the handball players.

The results, presented in Table 2, show that for all the indicators studied, the distribution of the data is normal and close to normal. Handball is a sport where the main anthropometric data required are height, weight, long limbs, and positive horizontal stretch. When analyzing the data in Table 2, it becomes clear that the average height of the studied group is 182.90 cm, but a large range of 23 cm is observed. Our tallest competitor is 193cm, and our shortest is 170.

When compared with non-sporting teenagers (Nacheva et al, 2012), it is striking that the highest height is 194.2 cm, which clearly shows that there is potential in the selection of tall handball players. A very important indicator for the handball play-

er, especially when handling the ball, is the length of the span, and here we can say that the handball players are lagging behind. The maximum span length for athletes is 26.00 cm, and for non-athletes, it is 27.20 cm, which confirms our thoughts regarding the selection.

Table 2. *Average values and dispersion indicators for the investigated signs*

№	Anthropometric indicators	number	$\overline{X}$	X min	Xmax	R	S	V%
1	Height	22	182.90	170.00	193.00	23.00	5.60	3.06
2	Weight	22	74.00	60.00	95.00	35.00	8.18	11.05
3	A wave of arms	22	184.09	173.00	196.00	23.00	6.75	3.66
4	Shoulder width	22	44.63	41.00	49.00	8.00	2.17	4.86
5	Lower limb length	22	103.45	96.00	111.00	15.00	3.52	3.40
6	Span length	22	23.18	21.00	26.00	5.00	1.33	5.73
7	10x15 м	22	30.90	28.00	34.00	6.00	1.47	4.75
8	Standing long jump	22	244.63	215.00	280.00	65.00	21.20	8.66
9	Smooth running 20 m	22	2.97	2.65	3.39	74.00	20.10	67.76
10	Handball throw	22	42.36	33.00	50.00	17.00	3.84	9.06
11	Defensive move	22	9.54	8.00	11.00	3.00	0.67	7.02
12	Throwing a ball 3kg.	22	8.90	7.00	11.00	4.00	1.06	11.91

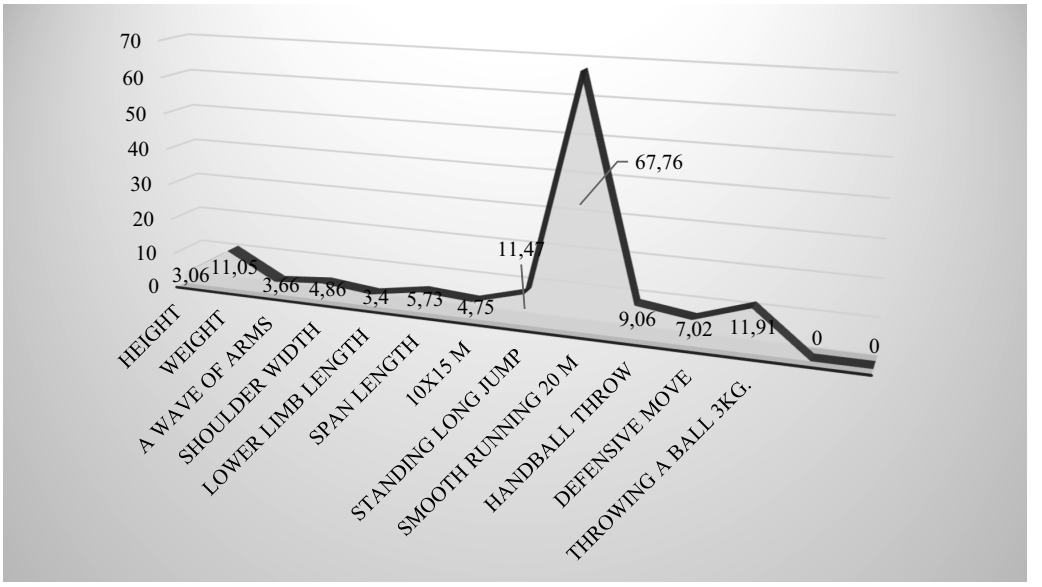

Figure 1. *Variability of anthropometric and sports-technical indicators*

For greater clarity, the data are presented in Figure 1, which reveals the variability of the studied individuals.

The results of our research (Figure 1) give reason to consider that, in general, the studied population is homogeneous in terms of the studied characteristics. Exceptions are "standing long jump" V = 11.47% and "throwing a ball 3 kg" V = 11.91%, which speaks of relative heterogeneity in physical fitness indicators. For the indicator carrying information about running speed, the coefficient of variation is V = 67.76%, which indicates that the dispersion of the indicator is large and the sample is heterogeneous. This is due to the fact that there are handball players with very good achievements, as well as those with mediocre results. We can attribute this fact to the speed of the reaction at the start, the starting acceleration, as well as the explosive power of the lower limbs.

The results obtained from our study of the anthro-

pometric indicators and the specific fitness of 17-18year old handball players from the national team of Bulgaria allow us to consider that the studied group is homogeneous in most of the studied indicators. Hesitation was observed in the "two-legged jump" and "3 kg ball throw" tests. For the indicator carrying information about running speed, the coefficient of variation is V = 67.76%, which indicates that the dispersion of the indicator is large and the sample is highly heterogeneous. This is due to the fact that there are handball players with good achievements as well as those with mediocre results. We can attribute this fact to the speed of the reaction at the start, the starting acceleration, as well as the explosive power of the lower limbs.

The development of coordination abilities of upper and lower limbs is an important condition for increasing the level of technical skills and speed-power qualities of adolescent handball players.

CONCLUSION

The peculiarities of the physique are to a large extent a prerequisite for the successful performance of the handball player. In our research, we find that there is potential in the anthropometric indicators in the junior national handball team up to 18 years of age, and this creates the necessary prerequisites for a differentiated approach in the selection of talented children for the game of handball.

Considering the age characteristics of the handball players, we recommend that the future educational and training process should be aimed at increasing and improving the level of signs of physical and technical-tactical readiness. In our opinion, this can be achieved through intensification of the educational and training process.

The direction of the coaches should be to apply more exercises for special quickness with and without the ball (starting quickness in view of the smaller distance of the running distance – 20 meters), exercises to improve the speed-power capabilities of the handball players. Emphasis should also be placed on the improvement and improvement of the basic handball skills, and the specific handball exercises must be performed at high speed.

Management of the training process by coaches should be related to its regulation, i.e. with the structuring and adjustment of training sessions. A very important point in conducting the training is to be consistent with the age of the competitors and their qualifications.

REFERENCES

Avramov, E. (2015). *Aktualni problem v podgotvkata na podrastvashti handbalisti. NSA* PRESS.ISBN 978-954-718-427-5.

Avramova, M. (2020). Izsledvane na zavisimostite mezdu antropometrichnite I sportno pedagogicheskite testove pri handbalni vratari. *Godishnik na National Sports Academy "Vasil Levski", Volume 2, Sofia: NSA Press, 258-264, ISSN 2682-9908.*

Antonova, V (2015). *Optimizirane na nachalnoto obuchenie po voleibol.*BOLID-INS.S. ISBN 978-945-394-174-2.

Asparuhov, I (2020). Analiz na antropometrichnite pokazateli I spezifichnoto predstaviane pri unoshi basketbolisti. *Godishnik na National Sports Academy "Vasil Levski",* Volume 1, Sofia: NSA Press, 15-22, ISSN 2682-9908.

Borukova, M, Peikov (2020). Sravnitelen analiz na nivoto na fizicheska deesposobnost na 15-16 godisni uchenizi predi I sled perioda na izolazia za COVID-19. *Godisnik na National Sports Academy "Vasil Levski",* Volume 2, Sofia: NSA Press, 294-305, ISSN 2682-9908.

Varbanov, I (2015). *Savremenni tendenzii v handballa.* NSA PRESS.ISBN 978-945-718-425-1.

Nacheva, A et al (2012). *Fizicheskotot razvitie na dezata I unoshite v Balgaria na granizata na 20 I 21 vek*. Akademichno izdatelstvo na BAN, ISBN 987-954-322-444-9.

Chanev, S (2013). Ozenka na rezultatite ot sportnata podgotovka na handbalistite 12-13 godidni ot obora na Spartak - Varna. *Sport I nauka*. Izv. No. 3, ISSN 1310-3393

Yotov, I. (2011). *Handbal optimizirane na podgotovkata.* Monografia. S. ISBN 978-954-90886-9-4

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RELATIONSHIP BETWEEN ANTHROPOMETRIC INDICATORS AND FITNESS ABILITIES OF ADOLESCENT HANDBALL PLAYERS

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ABSTRACT
Modern handball is characterized by high motor activity and high intensity of game actions, requiring the player to mobilize his physical, mental, and technical-tactical abilities to the limit. Naturally, this is possible only by maintaining a high level of conditioning abilities, which find external expression in the form of various movements. Objective - The present work is to investigate the relationship between some anthropometric parameters and conditioning abilities of adolescent handball players. The contingent of the study are 11-12-year-old handball players who participated in handball groups at HC "Lokomotiv" Gorna Oryahovitsa. Mathematical and statistical methods - variation and correlation analysis.
The analysis of the obtained results for the anthropometric parameters of 11-12-year-old handball players shows that the individual units and segments are relatively uniform. This is due to the selection, as well as the development of the child's organism.
The established level of special motor fitness shows that the studied group is homogeneous in terms of the measured fitness indicators. The presence of certain fluctuations in the handball throw and 800 y ball tests is due to the still unstrengthened musculoskeletal system and the level of technical training.

Keywords: *handball, anthropometric parameters, motor abilities, adolescent handball players*

INTRODUCTION

Modern handball is a dynamic system that requires manifestations of various motor qualities, perfect mastery of technical skills, their rational application in any specific competitive situation with a high psychological setting for conducting the sports struggle with the opponent.
In the game of handball, motor activity is manifested in the form of motor actions of different structure and form. Their successful implementation in practical activity depends on the level of mastery of technical skills, as well as on special physical qualities, which in their essence manifest as exercises performed with different power.

We are witnessing constant changes in the game of handball. With rule changes that are often said to be only "cosmetic" and not have enough impact on the development of the game itself, the game has changed significantly over the decades and the best witnesses to these events have been and remain Olympic handball tournaments. which always brought new trends and were the forerunners but also the crossroads of some future movements in handball.
With the latest innovations that the International Handball Federation has introduced, namely changes in the execution of the kick-off, where there is now a circle with a diameter of 4 meters and the condition is that the handball player touches any part of it with his foot, so after a goal is scored the goalkeeper can mount a lightning counterattack. The second change concerns the passive play rule, where after raising the referee's hand for a passive attack, passes are reduced from 6 to 4.

The game has become much faster, more dynamic, and extremely spectacular. This inevitably raises the demands on those who practice it, and the level of speed-strength training is within the reach of the attention of sports specialists. A complex development of motor skills is necessary, at the basis of which is the priority work to develop speed-power abilities, which, combined with virtuoso technique, give this game beauty and magic, which makes it a favorite sport of many people. Naturally, this cannot be possible without the introduction and use by coaches of theoretical-methodical programs and their practical application
The game of handball is accessible to all age groups and is very well received, given its exciting and competitive element and high emotionality.

In its essence, handball is based on basic human movements such as walking, running, jumping, and throwing. Combined with the introduction of the rules, the game allows for quick learning and practice. This, in turn, makes it accessible to all ages and genders. On the one hand, young people play because it gives them pleasure and joy. On the other hand, the game develops motor skills and habits in the adolescent organism (Avramov, 2022).

Physical development is a set of morphological, somatotypological, functional, and physiometric signs of the organism, which are called anthropometric signs (Mavrudiev, 2021). They characterize those aspects of the shape and structure of the human body that determine certain motor qualities and are related to motor performance and human health (Asparuhov, 2020).

In the game of handball, motor activity is manifested in the form of motor actions of different structures and forms. Their successful implementation in practical activity depends on the level of mastery of technical skills, as well as on special physical qualities, which in their essence manifest as exercises performed with different power.
These occurring qualitative and quantitative changes in the structure of the handball game require from the sports specialists a systematic study and search for the main factors influencing the game efficiency of the handball players.
On the one hand, this creates the necessary prerequisites for the maximum evaluation of the performance of a given athlete or team, and on the other hand, it allows experts to maximally evaluate the performance of a given athlete or team, and on the other hand, it allows the experts to draw the necessary conclusions and accordingly, corrections in the educational and training process.
That is why the study of specific motor skills and qualities will create real prerequisites for optimizing the motor activity of adolescent handball players and for improving selection.

METHODS

The contingent of the study are 11-12-year-old handball players, who participated in handball groups at HC "Lokomotiv" Gorna Oryahovitsa.

The aim of the present study is to investigate the relationship between some anthropometric indicators and the conditioning abilities of adolescent handball players.

The subjects of the study are the parameters of physical development and conditioning abilities of adolescent handball players.
The object of the study is the morphological and conditioning characteristics of handball players.

When conducting the research, the parents of children are informed about the study and gave signed informed consent for their children to be included and studied.
To solve the set tasks, we used the following scientific methods:
Research, analysis, and summarization of literary sources.
Sports and pedagogical testing.
Mathematical and statistical methods - variation and correlation analysis.

RESULTS

The main source of data is the anthropometric characteristics – lengths, widths, circumferences, weight, etc. Anthropometric data can be grouped as measured in a static position (such as our studies) and functional-dynamic related to motor function.

The data from table 1 shows that the average height values for 11-year-old handball players are min 136 cm and max 162 cm. The coefficient of variation V = 4.70% indicates that the group as a whole is relatively homogeneous, i.e. there are not many children practicing handball with large height differences.

Table 1. *Variational analysis of anthropometric indicators of 10-11-year-old handball players*

Anthropometric indicators	**n**	**x_{min}**	**x_{max}**	**R**	**x**	**S**	**V**
Height	14	136	162	26	148.00	6.95	4.70
Weight	14	29.2	63	33.8	40.93	7.73	18.87
Arm stretch	14	133	161	28	146.83	7.47	5.09
Span width	14	14.2	18.2	4	16.22	0.89	5.47
Span length	14	17.5	21.5	4	19.38	0.97	5.00
Shoulder	14	26	36.5	10.5	32.59	2.18	6.69
Lower limb	14	73.4	89.6	16.2	83.3122	0.62	4.76

The average value of body weight is = 40.94 kg. A very large variability of this indicator is observed V = 18.87%, i.e., it confirms the large non-uniformity of children in terms of body weight. This is typical for children of this age, it is due to the way of life.

The results obtained for span length are as follows: mean = 19.38 cm, with 17.5 cm and = 21.5 cm. Coefficient of variation V = 5.0%. It can be said that there is no significant difference between the span parameters.

Figure 1. *Scattering of anthropometric indicators for 10-11-year-old handball players*

On Figure 1 presents the values of the dispersion index we applied - V. In our case, its application is correct, since we have studied proportionally scaled quantities that are relatively symmetrically located. It is noteworthy that the results obtained for body lengths (individual units and segments) are relatively uniform except for weight. This is due to the biological features related to the growth and development of the child's organism, as well as to the selection of children for the game of handball.

In the game of handball, motor activity is manifested in the form of motor actions of different structure and form. Their successful implementation in practical activity depends on the level of mastery of technical skills, as well as on special physical qualities, which in their essence manifest as exercises performed with different power. The researches of I. Yotov (2011), E. Avramov (2015), and Borukova (2020) reveal the speed-power nature of the motor activity of the handball player.

Therefore, the study of conditioning abilities will create real prerequisites for optimizing the motor activity of adolescent handball players and for improving selection.

Table 2. *Variational analysis of conditioning abilities of 10-11-year-old handball players*

	n	X min	X max	R	X	S	V
Long jump	14	0.85	1.75	0.9	1.38	0.17	12.25
Running 20m	14	3.15	5.22	2.07	4.04	0.43	10.58
Running 30m	14	4.05	6.42	2.37	5.57	0.44	7.95
30m dribble	14	6.1	7.96	1.86	6.94	0.51	7.34
Handball throw	14	10.5	23.2	12.7	17.10	3.46	20.23
800 g throw	14	5.5	16.5	11	9.90	2.26	22.84
600 m	14	3.05	4.5	1.45	3.63	0.42	11.47

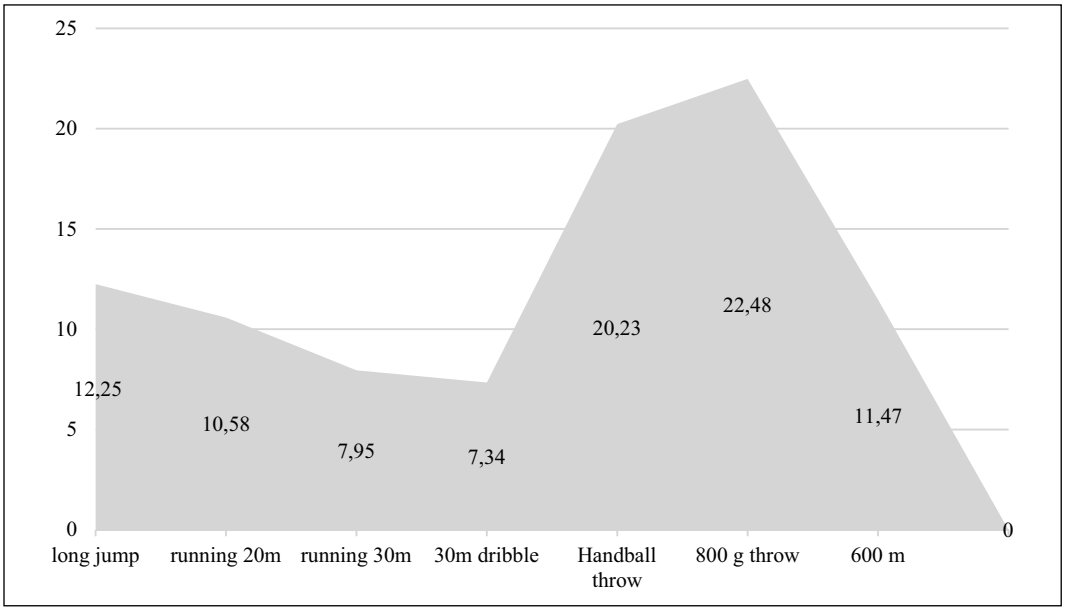

Figure 2. *Variability of conditioning abilities in 10-11-year-old handball players*

From the data presented in Table 2, we can see that the only indicators where relative heterogeneity is noticeable are "handball throw" = 17.10 m; V = 20.23%, and "throwing an 800 g ball = 22.84%; This is due to the fact that there are children with very high achievements as well as children with mediocre results. When throwing an 800 g ball, the picture is similar.

The established level of special motor fitness gives us reason to claim that the studied group is homogeneous in terms of the studied indicators. Fluctuation was observed in the handball throw and 800 g ball throw tests. This is due to the selection made. There are many talented children as well as those with mediocre abilities. From an ethical point of view, children with lower motor potential should be redirected to other sports.

Table 3. *Relationships between anthropometric indicators and conditioning abilities for 10–11-year-old handball players*

	Height	**Weight**	**Arm stretch**	**Span width**	**Span length**	**Shoulder**	
Long jump	.415**	.349*	.442**	.294	.362*	.217	.381*
Running 20m	-.788**	.419*	-.085	-.213	-.026	-.242	.428*
Running 30m	-.625	.382*	.003	-.128	.008	-.201	.311
30m dribble	.583**	.038	-.064	-.22	.093	-.338*	-.103
Handball throw	.454**	.357*	.400**	.101	.381*	.339	.334*
800 g throw	.780**	.355*	.436**	.476**	.373*	.494*	.391*
600 m	.609**	.375*	.308	-.422**	.358*	-.502*	.084

The data presented in Table 3 show the correlation dependences between the investigated indicators characterizing the anthropometric and sports-technical characteristics. The moderate and mostly significant correlation of height with almost all fitness indicators is striking. Empirical experience and research in adolescents show that height is a major anthropometric trait in adolescent handball players. For the weight indicator, mostly moderate dependencies were observed in most of the tests (r = .327 g, r = .419). The lack of higher correlations is due to uneven weight gain in most of the children, which is related to their biological development and lifestyle. The width and length of the span corresponds mostly to ball handling.

CONCLUSION

Regardless of substantial scientific research and studies, the problem of the initial selection of gifted children is in the stage of scientific research and

new scientific developments. Scientifically based methods of selection in the child-adolescent age, as well as prediction of future desired results, have established themselves as an essential part of the modern system of sports training from the initial stage to the level of elite sports.

One of the important characteristics for a good handball player is related to his anthropometric status, which is also a criterion for objective and impartial selection (Dukic, 2020).

E. Avramov (2022) defines the selection of young handball players as a complex, comprehensive pedagogical process aimed at revealing the potential opportunities of the younger generation to achieve high results in the handball game.

The correct selection of the handball player can be realized only with the help of a scientifically based methodology, the use of normative-evaluation tables and measurable parameters, which leads to objectivity in sport-pedagogical diagnostics

The analysis of the results obtained for the anthropometric indicators of 10-11-year-old students practicing handball shows that the individual units and segments are relatively uniform. This is due to the selection, as well as the development of the child's organism.

The established level of special motor fitness shows that the studied group is homogeneous in terms of the measured fitness indicators. The presence of certain fluctuations in the "handball throw" and "800 g ball throw" tests is due to the still unstrengthened musculoskeletal system and the level of technical training.
The correlation analysis made reveals the importance of anthropometric lengths in adolescent handball players, as well as the proportionality of span lengths, which is important in ball manipulation.

The development of conditioning abilities is an important condition for increasing the level of technical skills and speed-power qualities of adolescent handball players.

REFERENCES

Avramov, E. (2015). *Aktualni problem v podgotvkata na podrastvashti handbalisti.* NSA PRESS.

Avramov, E. (2022). *Handball teoria I metodika.* NSA PRESS.

Asparuhov, I (2020). Analiz na antropometrichnite pokazateli I spezifichnoto predstaviane pri unoshi basketbolisti. *Godishnik na National Sports Academy "Vasil Levski",* Volume 1, Sofia: NSA Press, 15-22, ISSN 2682-9908.

Borukova, M, Peikov (2020). Sravnitelen analiz na nivoto na fizicheska deesposobnost na 15-16 godisni uchenizi predi I sled perioda na izolazia za COVID-19. *Godisnik na National Sports Academy "Vasil Levski",* Volume 2, Sofia: NSA Press, 294-305, ISSN 2682-9908.

Dukic, D. (2020).3:2:1 Povratak korenima. Aleksandrovac,Beograd. COBISS.SR-ID 129558217 ISBN 978-86-902166-0-4

Mavrudiev, P. (2021). Physical development and ability to act of students with different professional orientation Monograph NSA PRESS ISBN 978-954-718-670-5

Yotov, I. (2011). *Handbal optimizirane na podgotovkata.* Stovi EOOD. S. ISBN 978-954-90886-9-4

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STUDY OF MANUAL DEXTERITY (DEXTERITY) IN 10-11-YEAR-OLD RHYTHMIC GYMNASTS

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ABSTRACT
In modern rhythmic gymnastics, there is an increasing difficulty with the apparatus, but for this to happen very good coordination of gymnasts is needed. In particular, dexterity is extremely important in order to be able to handle their devices very quickly and to perform as many elements of the apparatus as possible in order to receive higher grades. Manual dexterity is the ability of gymnasts to use their hands in a skillful, coordinated way to grasp and manipulate equipment and demonstrate precise movements. In view of this, the need for research on manual dexterity and its development is very much needed. The aim of the present study is manual dexterity (dexterity) in 10-11-year-old rhythmic gymnasts. Ten tests and fifteen exercises are offered as an experimental methodology for manual dexterity. A questionnaire was conducted with specialists in rhythmic gymnastics on the topic of this study After the results of the questionnaire, we can report that most coaches confuse the development of physical quality with the improvement of the technique of gymnasts. After the applied experimental methodology, we report an improvement in the results in the experimental group of 10-11-year-old gymnasts engaged in rhythmic gymnastics. In 9 of the 10 specific tests, we report a statistically significant difference in the results of an experimental group after the experiment. We believe that our methodology is one of the first of its kind. After statistically significant differences were found and proven in the present work, we can recommend to specialists working with adolescent gymnasts to get acquainted with it and use our experimental methodology. It will be suitable for improving dexterity and easier study and implementation of complex coordination elements with the apparatus.

Keywords: *Rhythmic Gymnastics, Coordination, Handling, Apparatus, Methodology*

INTRODUCTION

Rhythmic gymnastics is a difficult and complex sport that requires increased Spatio-temporal coordination between body movements and handling the apparatus, making specific motor coordination a vital part of technical training in rhythmic gymnastics (Purenovic-Ivanovic et al, 2016). Rhythmic gymnastics exercises reveal the aesthetic and artistic side of the performance, which materializes in unity and fluidity, bodily elegance, and harmonious coordination of body movements and motor expressiveness. The connection between the movement of the body and the handling of the apparatus is skillfully introduced to the viewer, the object that the gymnast manipulates becomes a continuation in the space of the segments of her body and at the same time a means of motor expression (Macovei, 1999). Manipulation of the apparatus reveals the optimal neuromuscular control of gymnasts, which helps them achieve movements with great finesse. In the absence of good coordination, one cannot develop the specific motor skills and perform them accurately to achieve an achievement (Nastase, 2011). The appropriate combination of sensory and motor elements leads to correct and precise movements, leading to an improved connection with the specific objects of rhythmic gymnastics and therefore to a better performance on the competition floor. This makes the topic of improving coordination in the world of rhythmic gymnastics extremely important (Iorga, A. 2019). Agility is a complex quality that is specific to individual sports disciplines. Its main measures are the coordination complexity of motor actions, the accuracy of movements, and the time of execution. The coordination complexity of motor actions is the realization of a certain coherence of movements, through which motor tasks are solved, related to the deft transition from one position (movement) to another, deftly manipulated with the various devices, which is the most typical example of the manifestation of this quality in rhythmic gymnastics. The deftly, dexterous, and precise performance of the exercises and combinations leads to an economy of effort, to a high coefficient of useful action, and a reduction in the amount of mistakes made (Atanasova, Shishkova, 1989). According to G. Sergiev (2003), the coordination of movements as a complex quality is important in the training of complex-coordination exercises and in the execution of movement patterns. The presentation of combinations in which exercises with a complex coordination structure prevail, combined with original choreography, is an indicator of high sportsmanship (Gancheva, 2017).

PURPOSE AND TASKS:

The aim of the present study is manual dexterity in 10-11-year-old rhythmic gymnasts. To achieve the

set goal, the following tasks have been defined:

- Conducting testing to control the level of development of the motor quality of agility in 10-11-year-old gymnasts.
- Preparation of an exemplary experimental methodology for improving dexterity in rhythmic gymnastics of 10-11-year-old gymnasts and its testing in practice.
- Conducting a second test control at the end of the experiment and processing the results.
- Comparative analysis of the results obtained from the conducted experiment.

METHODS

The research methodology went through the theoretical-analytical method, expert assessment, and statistical methods. After permission from the coaches, we informed the parents of the studied children about the purpose of the experiment. They declared in a written form their consent for their children to be tested and for their results to be used for scientific purposes.

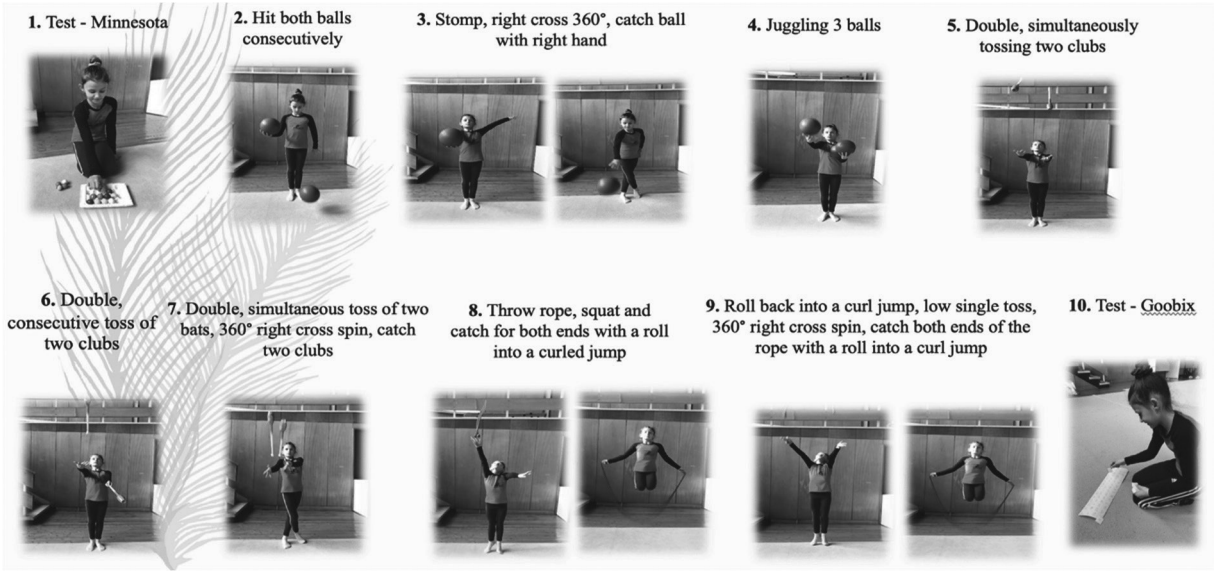

Figure 1. *Agility Assessment Tests*

We have set ten tests (Figure 1), two of which are atypical for rhythmic gymnastics and are measured with a stopwatch. The remaining eight tests are author's and evaluated by expert evaluation.

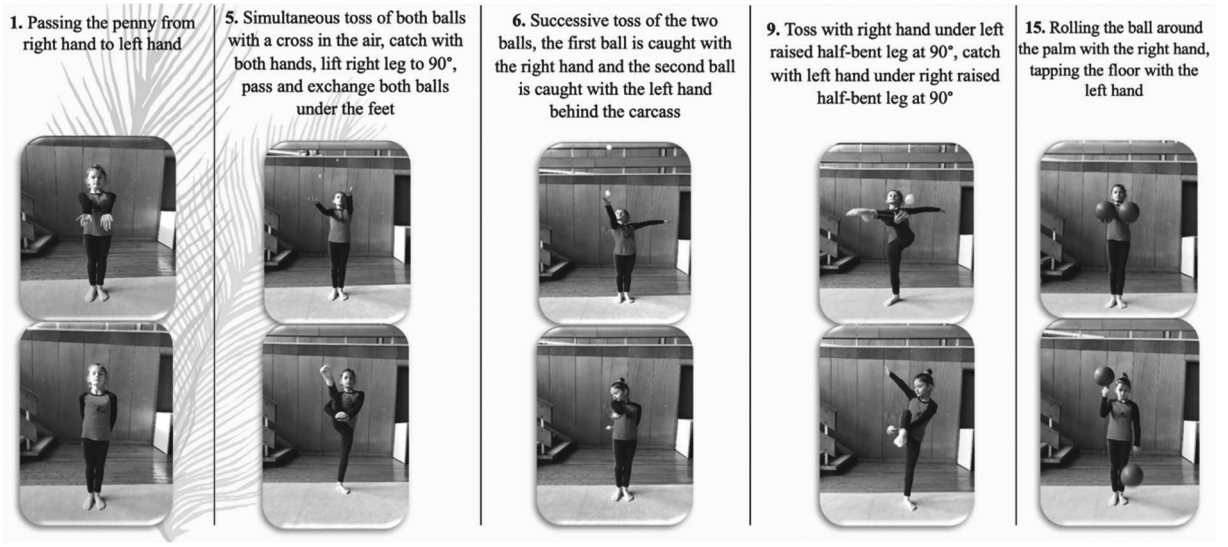

Figure 2. *Exercises from the experimental methodology in the study*

Only five exercises from the proposed experimental methodology were set (Figure 2), and all exercises are fifteen in number. Equipment such as pennies, rubber balls, table tennis balls, tennis balls, as well as

gymnastic balls have been used. Extremely different equipment and atypical for rhythmic gymnastics.

RESULTS

We have presented the results of Test 1 (Minnesota), where it is required to place the marbles in a special box as quickly as possible. We obtained very close times of the gymnasts from the experimental group, examined before and after applying the experimental methodology.

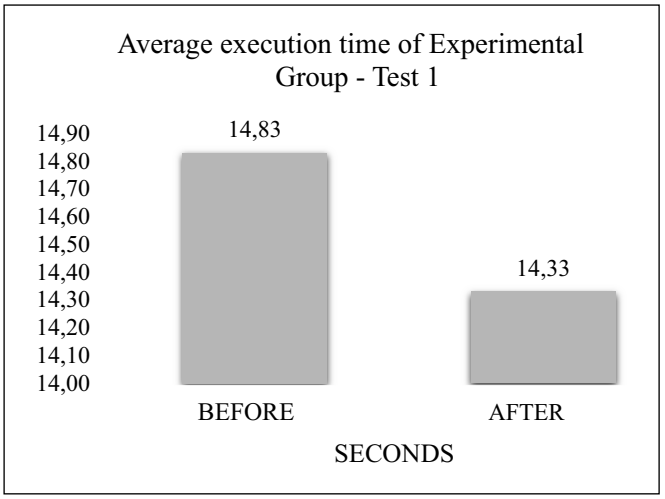

Figure 3. *Results of the Experimental Group – Test 1*

In the remaining eight tests, we observe a large increase after the applied experimental methodologyton the experimental group. Test 2 (Successful tapping of both balls), Test 7 (Simultaneous toss of both clubs, 360° cross rotation and catch of both clubs), and Test 9 (Reverse rope roll into a curled jump, low single toss, right 360° cross spin, catch both ends of the rope with a roll into a curl jump) are performed with different equipment and require coordination abilities to perform correctly, but have the greatest increase in results.

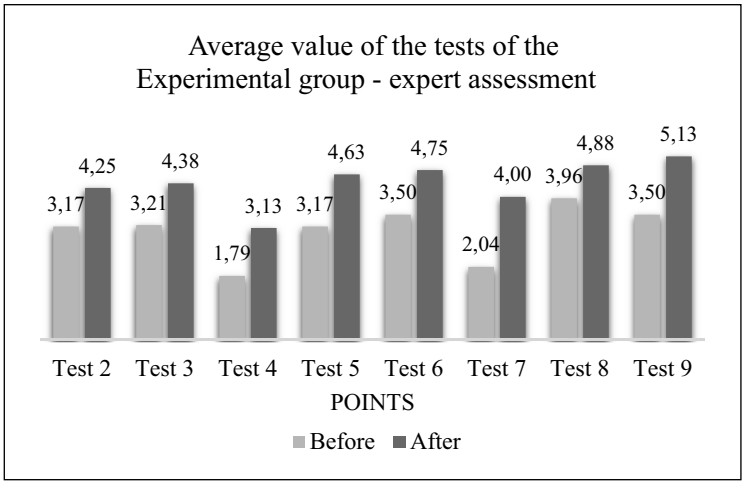

Figure 4. *Results of the Experimental group – the remaining eight tests*

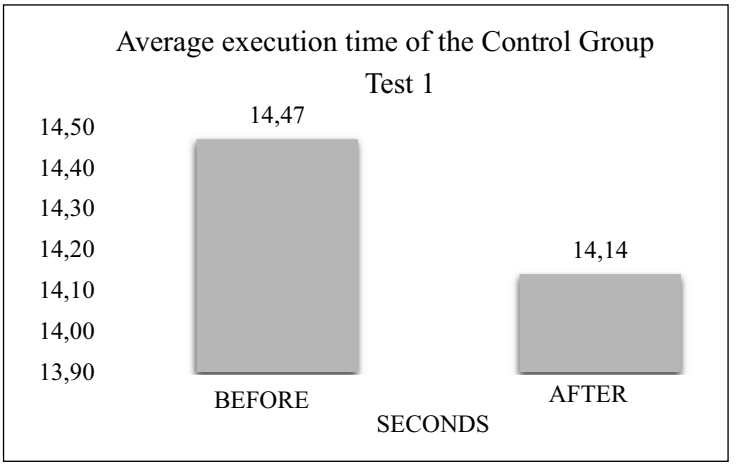

Figure 5. *Results of Control Group – Test 1*

Test 1 in the control group, before and after the implementation of the experimental methodology, a statistically reliable increase was observed, in contrast to the result in the experimental group, where we have no reliable difference in the results.

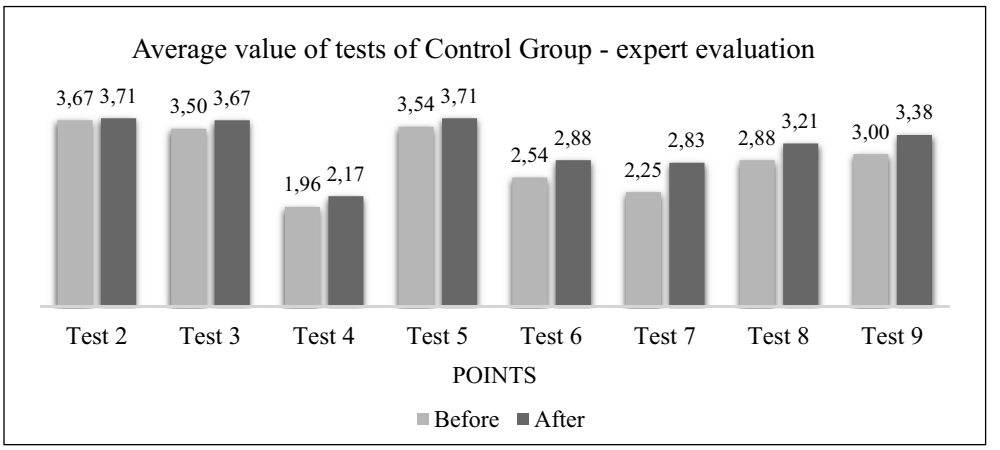

Figure 6. *Results of Control Group – remaining eight tests*

In two of the tests (Test 4, and Test 8) we have a significant increase, in the rest of the tests, the results are very close to the initial points that the gymnasts received.

Table 1. *Analysis of Supplementary Test Results and Pearson's Correlation Coefficient.*

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
Test 1 Minnesota										
Test 2 Dribbling balls	-.396									
Test 3 Tapping, spinning, catching	-.329	.366								
Test 4 Juggling balls	-.364	**.575**	**.529**							
Test 5 Simultaneous tossing of clubs	-.500	.391	**.607**	**.616**						
Test 6 Consistent tossing of clubs	-.283	.117	.237	**.612**	**.554**					
Test 7 Simultaneous tossing of clubs, spin, catch	-.252	**.521**	.401	**.586**	**.537**	**.564**				
Test 8 Throwing rope, squat and catch	.154	.314	.499	**.707**	**.611**	**.568**	**.527**			
Test 9 Tossing a rope, spinning, catching both ends of the rope	-.218	.301	**.643**	**.618**	**.700**	**.584**	**.596**	**.697**		
Test 10 Goobix	-.150	-.121	.085	-.226	-.186	-.432	-.299	**-.542**	-.073	

We consider that Test 10 (Goobix), which is not specific to rhythmic gymnastics, comes closer to the agility test we are looking for Test 10 can completely replace Test 1 (Minnesota).

DISCUSSION

The results show an increase after the proposed methodology in the experimental group. In all tests we have a statistically reliable increase, only in Test 1 there is no such difference, which we attribute to the difference in the dynamic structure of the test and the exercises with a device in rhythmic gymnastics. In the remaining eight tests, we have a statistically significant difference. In Test 2, coordination is required when hitting the two balls consecutively and not at the same time. Test 7 is the most complex of the three club tests, as they successively increase in complexity and reach simultaneous throwing of both clubs, 360° cross-rotation, and catching of both clubs, which is a complex exercise for children of the age we study in our work. In Test 9, an exercise is performed, which often has to be used in gymnasts' routines, because it meets the requirement of the rules to catch both ends of the rope, therefore it is a basic technical element. The results of the control group show that in a total of three of the tests (Test 1, Test 4, and Test 8) there is a statistically significant difference even though we did not apply our experimental methodology. This is normal because gymnasts work on quality and technique, which invariably leads to improved results. We can summarize that after the applied experimental methodology, we report an improvement in the results of the experimental group in 10–11-year-old gymnasts engaged in rhythmic gymnastics. The important thing is that with our methodology the increase is positive and statistically significant in eight of the nine tests and as final results the experimental group has much higher and better values than the control group. When processing the results of the additional testing and the Pearson correlation coefficient (Table 1), we can report after the first study of the two tests of the gymnasts and the applied experimental methodology that the selected Test 1 (Minnesota) did not show an improvement in the results. We think the reason lies in the fact that it tests the speed of reaction in its purest form, which differs little in dynamics from the exercises characteristic of rhythmic

gymnastics. We decided to use a new test that differs in the structure of movements in rhythmic gymnastics but measures exactly the quality that we are interested in for our research. To approximate the structure of the remaining tests, we used Test 10 (Goobix) instead of Test 1 (Minnesota) from Magill, (1989). The original test required arranging cards from 1 to 100. We have modified the test to 60. The new test involves arranging cards with numbers 1 to 60 on a card with the numbers 1 to 60 scrambled. The test is timed with a stopwatch in seconds. Make sure that each card is placed on the same number. After adding a new test and conducting new testing, we report that we are much closer to finding a test for the study of manual dexterity. With the new Test 10 (Goobix), we have a correlation with Test 8, and with Test 1 (Minnesota), which we wanted to replace, we have no correlation with any of the proposed tests. Test 8 is performed with a rope and is one of the most complex tests included in our research. The rope apparatus is a basic apparatus in training in rhythmic gymnastics. The results and the correlation analysis between the tests show that we have a motor habit transfer from one device to another. Twice in different tests we have a high correlation between them of over 0.7. In Test 8 (rope toss, squat and double-ended catch with a curled jump) with Test 4 (juggling three gymnastic balls) as well as Test 9 (rope roll back in curled jump, low single toss, 360° right cross rotation, catching both ends of the rope with a roll into a curled jump) with Test 5 (double, simultaneous toss of two clubs). When we have a high correlation between one or more tests, we can reduce the tests used in order to save time and optimize control in the training process. We report after the tests and results that Test 10 (Goobix), which is non-specific for rhythmic gymnastics, comes closer to the agility test we are looking for. Test 10 can completely replace Test 1 (Minnesota). We believe that our methodology is one of the first of its kind. After statistically reliable differences were found and proven in the present study, we can recommend the specialists working with adolescent gymnasts to familiarize themselves with it and use our experimental methodology. It will be suitable for improving the quality of dexterity and making it easier to learn and perform complex coordination elements with the apparatus.

REFERENCES

Atanasova, T., Shishkova, T. (1989). *Hudozhestvena gimnastika*. Sofia, ECNPKFKCS – Izdatelstvo-pechatna baza.

Gancheva, G. (2017). *Hudozhestvena gimnastika slozhnost I koordinacia*. Sofia, Bolid Ins.

Iorga, A. (2019). *The importance of coordination in the world of motion.*

Magill, R. A. (1989). *Motor Learning Concepts and Applications*. Iowa: William C. Brown Publishers.

Jurgensen, C.E. (1943). Extension of the Minnesota Rate of Manipulation Test. *Journal of Applied Psychology*, 27, 164-169.

Purenovic-Ivanovic, T., Popović, R., Stanković, D., Bubanj, S. (2016). The importance of motor coordination abilities for performance in rhythmic gymnastics - UDC 796.412.012. *FACTA UNIVERSITATIS, Series - Physical Education and Sport* Vol. 14, No. 1, pp. 63-74.

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COMPARISON OF PERFORMANCE EFFICIENCY IN THE DISCIPLINE WOMEN'S SINGLES BETWEEN BULGARIAN AND FOREIGN BADMINTON PLAYERS

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ABSTRACT

The study aims to investigate the performance in the discipline Women's Singles among Bulgarian and foreign badminton players. Thirty matches - semi-finals and finals of international tournaments and state championships in badminton in 2020 and 2021 were studied.

The contingent of the study was 5 Bulgarian elite badminton players training at Badminton Club "Aneta Yaneva NSA". In addition, the playing efficiency of 10 foreign badminton athletes in the top 10 of the World Ranking List for 2020 - 2021 was studied for reference and comparison.

Using the author's methodology, 15 game indicators (strokes) were separated into three groups: attacking, defensive, and neutral, as well as the technical elements: service, meeting, and the realization efficiency of each individual indicator are derived.

The mathematical-statistical methods of variation and alternative analysis are applied to process the obtained data.

The results show a statistically significant difference in the game efficiency of the attacking type of shots (77% for the world elite badminton players compared to 35% for the Bulgarian players); defensive, respectively 7% of won plays by the foreign players compared to 46% by the Bulgarian badminton players; in the case of the neutral type of shots there were no significant differences in the two groups studied.

Keywords: *badminton, Women's Singles, winning shots*

INTRODUCTION

Badminton is a racket sport in which achieving high results places numerous and varied demands on the players. It is characterized by the interval-variable nature of the motor activity and the need for badminton players to master a wide arsenal of technical abilities.

In its historical development, badminton has undergone changes in various aspects. The technique of the game is constantly improving, and highly skilled athletes are profiled by disciplines. All this reflects on the planning, implementation, and control of sports training and competition. The changes in the Badminton Regulations over the years have affected the shape of the game and necessitated the search for innovative approaches to optimize the sports training model in the specificity of its individual disciplines. The problem arises from the need for a detailed study of the game's structure synchrony with its development. Information sources that relate to the analysis of game statistics are scarce. In the majority of studies, the authors address issues of the temporal structure of play (Phomsoupha, Laffaye, & Dor, 2015; Duncan, 2016).

Of interest to us is the research of Gomez et al. (2020). The authors characterize longer rallies during a match and their relationship to subsequent forced and unforced errors, winning finishing strokes for both genders. The performance efficiency of the technical-tactical actions is defined as the result of the quantitative evaluation of specific indicators: priority of performance, safety, effectiveness, types of initial hits and ways of meeting them, and dominant style of play (Ocheva, 2004). Therefore, studying the existing interrelationships between these indicators would have important practical-applied significance.

The text presents a comparative analysis of the winning finishing shots of badminton players, representatives of the world, and the Bulgarian elite in the discipline Women's Singles. The study was conducted to use the obtained data on this performance component to update specific parameters of the athletes' training programs to improve the effectiveness of their competitive game.

Thus, the set goal is associated with the solution to the following tasks:

1. Systematizing the data on the game activity from

official championships, realized by the leading in the world and Bulgarian elite badminton athletes in the discipline Women's Singles.
2. Tracking the average level and variability of the indicator *score* of game actions distributed by groups.
3. Comparison and analysis of winning strokes between the studied groups of badminton players.

The *object* of the research are components (game indicators) in competitive activity, determining the performance efficiency of highly qualified badminton players in the discipline *Women's Singles*. The *subject* of the study are the main indicators characterizing the scoring efficiency in badminton.

Contingent of the study

The contingent of the study are ten (10) athletes from the world women's elite, falling into the top 10 of the World Ranking List for 2019, 2020, 2021: He Bangjao, Pursala Sindhu, Sung Ji Hyun, Beiwen Zhang, Nozomi Okuhara, Ratchanok Intanon, Carolina Marin, Chen Yufei, Akane Yamaguchi, Tai Tzu Ying (Table 1), as well as 5 Bulgarian highly qualified athletes training in Badminton Club "Aneta Yaneva – NSA"- 4 women and 1 girl in the age group under 19 years, ranked among the top eight in the National Individual Championships (NICH) and the first three teams in the National Championships for Teams (NICHT) in 2019, 2020 and 2021 (Table 1, Table 2).

Table 1. *World elite, in the discipline Women's Singles, control group (CG)*

Name	Country	Playing style	Place in the World Ranking List	
			2020	2021
He Bangjao	PR China	attacking	7	7
Pursala Sindhu	India	attacking	3	6
Sung Ji Hyun	Korea	combined	9	8
Beiwen Zhang	USA	combined	10	9
Nozomi Okuhara	Japan	attacking	2	4
Ratchanok Intanon	Thailand	attacking	8	5
Carolina Marin	Spain	attacking	6	10
Chen Yufei	PR China	attacking	4	1
Akane Yamaguchi	Japan	combined	5	3
Tai Tzu Ying	Chinese Taipei	attacking	1	2

Table 2. *Bulgarian badminton competitors in Women's Singles discipline, experimental group (EG)*

Name, Surname	Age Group	RANKING			
		NICH 2019	NICH 2020	NICH 2021	NCHT 2021
1.M.M.	Women	2	1	2	3
2.M.Ch.	Women	5/8	9/16	5/8	3
3.E.T.	Women	5/8	3/4	5/8	3
4.L.S.	Women	3/4	5/8	9/16	3
5.Y.Y.	under 19 years old.	3/4	2	3/4	3

In the course of the research, the following diagnostic methods are used: observation, mathematical-statistical methods, variation, and comparative analysis. To account for the *result* and to objectively evaluate the achievement, 15 indicators (types of strokes) are observed: attacking clear, drop, smash, half smash, counterattacking stroke, net kill, drives, control, defense - short, net drop shot, standard clear, defense - long, lift, initial pass (service) - short, long, receive, separated into three groups (Table 3).

Table 3. *Game indicators by group*

TYPES OF SHOTS			
ATTACKING	**NEUTRAL**	**DEFENSIVE**	**SERVICE**
1. Offensive clear (OFCL) 2. Drop shot (DRSH) 3. Smash and jump smash (SM) 4. Half smash and fast drop (HSM) 5. Counter-attacking shots (CNTRA) 6. Net kill (NK)	1. Drive (DR) 2. „Control" (CN) 3.defence (short) (DFS) 4.Net drop shots (NDR)	1. Clear (CL) 2. defense (long) (DL) 3. Lift (net) (LN)	1. Long - FrH - BkH 2. Short - FrH - BkH

The *efficiency* indicator is determined by the following formula: winning shots by type relative to the total number of shots of the same type. The variables are quantitative quantities, in the unit *percentage* for each shot (Table 4).

Table 4. *Criteria and indicators of gaming activity*

Criteria	Indicators	Measurement unit
Score	By groups, by the type of the finishing blow	%

RESULTS

When comparing the *score* of the shots, the highest percentage of efficiency in the KG was reached in the group of *attacking* shots (77%), while the EG - was in *defensive* shots (46%). The data are not surprising, given the established *attacking* style of play, in a preliminary study of the world elite athletes and *defensive* in the Bulgarian athletes (Table 5).

Table 5. *Comparative data on the indicator Score by types of strokes (in percent)*

SCORE					
Group	Attacking	Neutral	Defensive	Serve	Receive
CG	77%	17%	7%	5%	8%
EG	35%	20%	46%	9%	24%

Thus, the presented results give a clear picture of the realization efficiency of the Bulgarian athletes compared to the badminton players of the world women's elite; they set specific goals and objectives in the methodology of work.

Figure 1 presents the results of the attacking efficiency of the female representatives of the world elite and the Bulgarian female athletes.

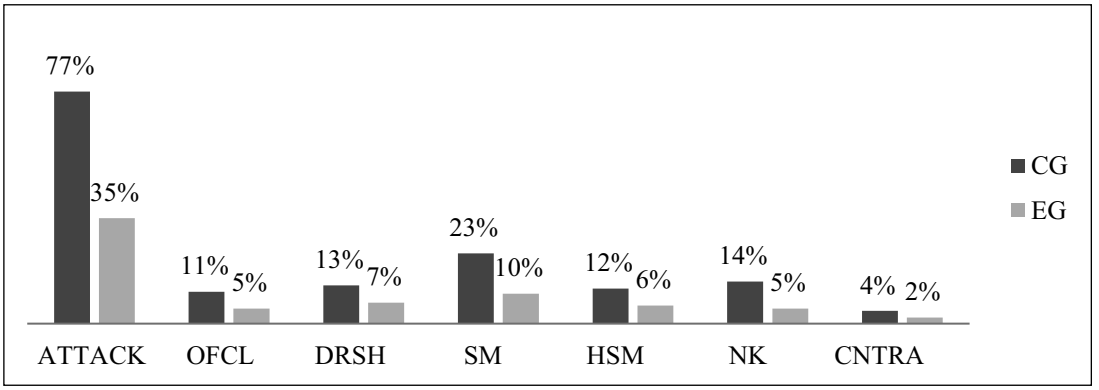

Figure 1. *Comparative data on the Score of the attack (in percent)*

The presented results show an advantage in all *attacking* shots, realized by the representatives of the world elite, compared to those of the Bulgarian competitors. This is most evident in the win-

ning *smash* shot of the world elite - 23%, against the 10% achieved by the Bulgarian badminton players. The percentage of points scored with the *mining* shot is also high - 14% for KG against 5% for EG. The data presented in Figure 2 show a 17% score (of the total score) for the *neutral* stroke group in the control group and 20% in the experimental group.

Both groups of examined persons have realized the highest share of points with a *net drop shot* - 12% for the representatives of the world elite and 15% - for the Bulgarian competitors (Figure 2).

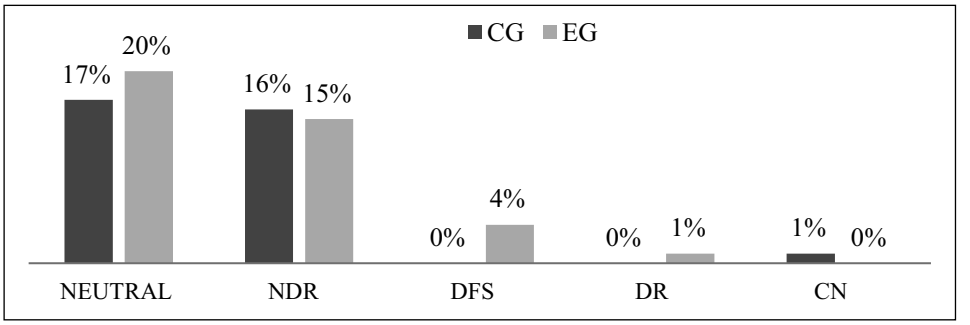

Figure 2. *Comparative data on the indicator Score of neutral strokes (percentage)*

The stroke *drop shot net* is not offensive, but its high percentage of realization efficiency is due to the skillful execution of the technique, as well as the appropriate choice of application in the specific play. The *drop shot net* can be executed with a spinning motion, falling close to the slice of the net, and playing it at a high percentage results in the shuttlecock being subsequently picked up or unable to be returned by the opponent. For the other types of strokes, it is noticeable that 4% of the completion of games was achieved by *the short defense* in the Bulgarian badminton players, while the representatives of the world elite have not won games with this stroke. When observing the matches in both groups, we found that the lack of results with this element in the elite athletes is related to the readiness of the opponent to move to the net after their attack, while in the Bulgarian badminton players, we can see *staying* on the back line or delay in moving to the front of the court after offensive actions. In this sense, we associate the high percentage of points scored by the Bulgarian athletes through *defensive short* with weaknesses in technique, both of execution and of movement after attacking actions.

Figure 3 presents the data on realization efficiency from the *defensive shots* group.

The data show that 8% of the world's elite representatives scored points through defensive shots. The percentage is much higher - 45%. Predominantly, for both groups, the points were scored by *pulling from the net*, but the difference in percentages is significant - 5% for the international badminton players and 20% - for the Bulgarian players (Figure 3).

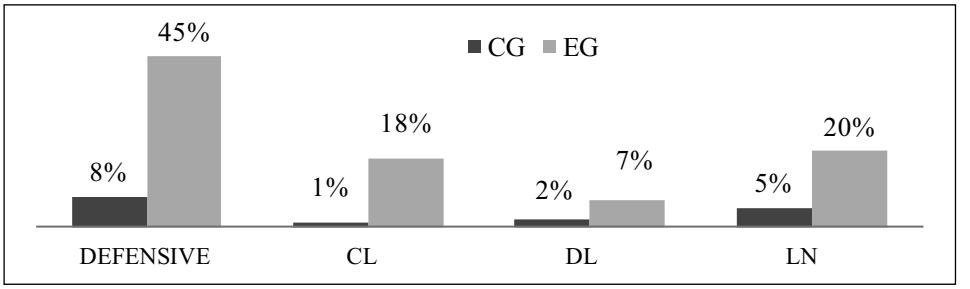

Figure 3. *Comparative data on the indicator Score of defensive shots (percentage)*

Despite the *lifting* of the net, when the shot is executed with higher speed and lower amplitude, it becomes an effective means of completing the play, which we observed in both groups studied. The EG showed a high percentage of completed plays through the element of *clear* - 18% - a defensive stroke with the tactical goal of moving the opponent to the back of the court or *returning* to the play by executing a high amplitude and depth. The data for games won through *long defensive* show 2% for KG and 7% for EG. We attribute the reason for this efficiency of the element for both groups

to the surprise of the opponent of directing the feather to the back of the court after executing offensive actions and hastily going to the front of the court.

Figure 4 presents the implementation effectiveness of the service element (Figure 4).

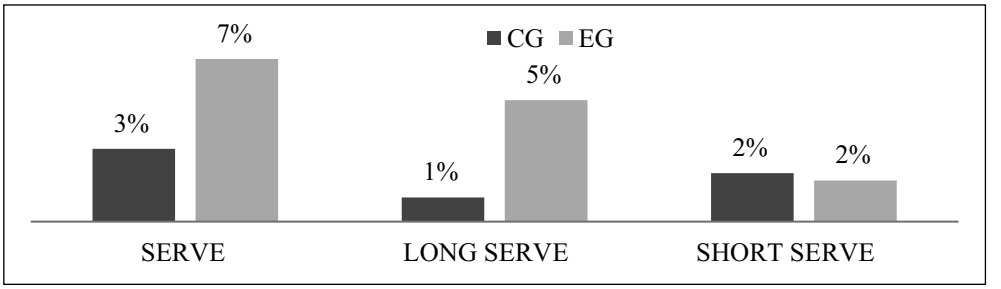

Figure 4. *Comparative data on the indicator Results of the serve (in percent)*

In the *score* indicator for the *service* stroke, we observe 3% of direct points scored by CG and 7% - by EG, of which the majority - 5% - are the games won by long service and 2% - by short service. A winning serve is when it is not met due to: non-play by the opponent - having fallen on the line or surprising (the opponent was expecting a long service, but a short service was executed). The high percentage of points scored by EG players is rather a sign of weakness for the overall level of Bulgarian badminton, given the age group studied and the neutral nature of the shot.

Realized direct winning plays in *receiving* the service in our studied athletes, representatives of the world elite, were 8% (4% by an attack, 3% by neutral shots and 1% by defensive actions), while Bulgarian athletes reached 24% realization efficiency of the receiving, distributed by shots by groups (Figure 5).

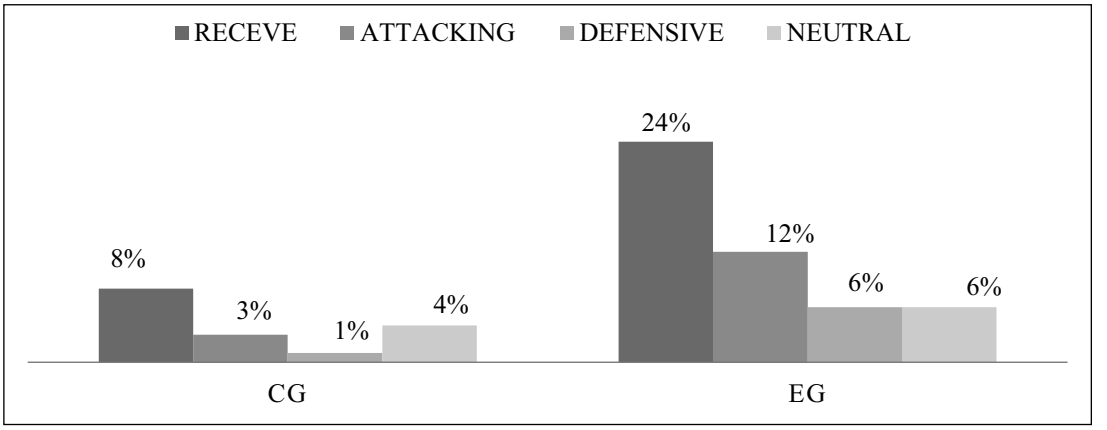

Figure 5. *Comparative data on the indicator Score of the strokes when receiving the shuttlecock (percentage)*

EG realized 24% of points earned directly from receiving. Expectedly, the highest percentage of points were those from offensive shots at 12%, followed by equal % points for neutral and defensive shots at 6%. In comparison, KG only realized 8% of draws won through *receiving*, distributed roughly equally across the three groups of strokes. We believe that the big difference between the two groups for the indicator *score* of the element *receive* is due to the fact that the KG players have a high level of physical and technical-tactical training, which allows long rallies with frequent changes of rhythm, variability and very good precision of motor actions against the background of constantly changing playing conditions. Directly won rallies from a receive are characteristic in rare cases, most often in cases of poor technical execution of the initial shot (short serve - high over the net) or because of an excellently directed received shuttlecock falling on the line in the opponent's field.

DISCUSSION AND CONCLUSION

The detailed comparison of the playing indicators between the top 10 in the world in women's singles and the Bulgarian badminton players brings to the fore:

1. The leading style of play in the Women's Singles

discipline in the world elite is *attacking* (48%), and for the Bulgarian badminton players - *defensive* (35%).

2. When examining the *predominant performance* of the attacking strokes, we find a significant lag in their use by the Bulgarian athletes compared to that of the representatives of the world elite. This is most noticeable in the case of the smash (16%) in the case of the world elite and (9%) in the case of the Bulgarian athletes.
3. Recent trends in the development of women's singles show balanced predominant execution of the type of service: long or short, while the data for Bulgarian players show that 82% of the games started with a *forehand long* serve and only 18% - with backhand short serve, which negatively affects the formation of an attacking style of play.
4. In terms of the *score* indicator, foreign players have won the most games by attacking shots: 77%, while for Bulgarian players, this percentage is 35%. With neutral strokes, both groups of badminton players have similar realization efficiency. With defensive shots, the Bulgarian players have the most won games - 46%, while the badminton players from the world elite - 7%. Bulgarian women have won, on average, 24% of the games with a direct point from a receive, while foreign badminton players - have 8%.

In conclusion, we believe that it is necessary to update the training program of the Bulgarian athletes and improve it mainly in two directions: improving the technique and game preparation of the athletes, along with improving their special physical preparation.

REFERENCES

Duncan, M. J., Smith, M., Bryant, E., Eyre, E., Cook, K., Hankey, J., Tallis, J., Clarke, N., Jones, M. V. (2016). Effects of increasing and decreasing physiological arousal on anticipation timing performance during competition and practice. *European Journal of Sport Science*, 16: 27-35.

Gomez, MA, Leicht, AS, Rivas F, Furley P. (2020) Long rallies and next rally performances in elite men's and women's badminton. *PLoS ONE* 15 (3): e0229604.

Ocheva, G. (2004). Izsledvane na strukturata I efektivnostta na napadatelnata igra pri visokokvalificirani sastezateli po tenis na masa. Disertacia. NSA. Sofia. // Очева Г. (2004). Изследване на структурата и ефективността на нападателната игра при висококвалифицирани състезатели по тенис на маса. Дисертация. НСА. София.

Phomsoupha, M. and Laffaye, G. (2015). The science of badminton: game characteristics, anthropometry, physiology, visual fitness and biomechanics. *Sports Medicine*, 45(4): 473-495.

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STUDY ON EXPLOSIVE POWER OF LOWER LIMBS IN RHYTHMIC GYMNASTICS

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ABSTRACT
Explosive power is a motor quality with wide application and need for development in various sports. Every sport requires different methods and training. For this reason, we have conducted some experimental work, whose goal is to do more specific research on explosive power in rhythmic gymnastics. The aim of the experiment is to study the development of motor quality "explosive power of the lower limbs" and the transfer of motor habits among 10 – 12-year-old female gymnasts. An experimental methodology consisting of 12 exercises for the development of explosive power of lower limbs has been applied for 2 months (3 times a week) to the experimental group. The "Vertical Jump", "Split Leap" and "Turning Split Leap" tests were used to check the transfer of motor habits. The analysis of the results has showed that after the sports-pedagogical experiment, the experimental group significantly improved their results – by 4,30 cm on the "Vertical Jump" test and by 16,10 cm on the "Standing Long Jump" test. We found a positive transfer of motor habit when comparing the results between "Vertical Jump" and "Split Leap". The study gives us reason to conclude that the experimental methodology, developed and applied in this study, works and can be used in coaching practice. Significant development of explosive power of lower limbs has been achieved in the 10- 12-year-old gymnasts and the ease of performing jumps was increased as well, which helps them to more easily learn and master their technical performance according to the requirements of rhythmic gymnastics and the FIG Code of Points.

Keywords: *jumps, horizontal effort, vertical effort, transfer of motor habit*

INTRODUCTION

The development of modern rhythmic gymnastics is increasingly dynamic and the demands on female competitors are constantly increasing. More and more complex elements are placed in the compositions, which require a rich arsenal of skills and qualities related to good technical and physical training. We chose to look at and explore one of the physical qualities required in this beautiful and difficult sport – the explosive power of the lower limbs. It represents the maximum value of strength that a given muscle can develop in the shortest possible time (Zheliazkov, Dasheva, 2002). This includes all speed-strength exercises in gymnastics, such as all one-foot or two-foot jumps. Force gradient is the primary quantitative indicator of explosive power level. It represents the ratio between the maximum force that a given muscle can develop, and the minimum possible time to reach it (Hadzhiev et al., 2011). The main methodological problem in training for dynamic (explosive) strength is maximal activation of fast-twitch muscle fibers. The main method for its development is the method of dynamic efforts, two of which have been developed: methods for developing quick strength and a shock method for explosive strength (Mihaylov, 2016). High jumps performed after a depth jump can be seen as means of development of explosive power in gymnastics through the shock (plyometric) method (Hadzhiev et al., 2011). Explosive power is a motor quality with wide application and need for development in various sports. Each sports discipline needs a different methodology and training. This led us to conduct experimental work aimed at its more specific study in rhythmic gymnastics. According to our working hypothesis, if our experimental methodology is systematically applied, this will lead to the development of the quality of explosive power of the lower limbs and the transfer of motor habits among 1012-year-old female gymnasts. This in turn will help to more easily learn and master the technique of performing jumps according to the requirements of rhythmic gymnastics and the FIG Code of Points.

Aim and objectives of the study

The main aim of the experiment is to study the development of motor quality explosive power of the lower limbs and the transfer of motor habits among 10-12-year-old female gymnasts. The main tasks that we have set are:

- Review of literary sources on the subject;
- Determination of the tests for measuring the explosive force of the lower limbs and checking the transfer of a motor habit in 10-12-year-old rhythmic gymnastics competitors;
- To develop and implement an experimental methodology for the development of explosive power of the lower limbs, among girls aged 10-12 years, engaged in rhythmic gymnastics;
- To analyze the proposed methodology for

the development of explosive power of the lower limbs and the transfer of motor habits in 10-12-year-old rhythmic gymnastics competitors according to the reported test results.

The object of the study is the quality of explosive power in rhythmic gymnastics. The subject of the present sports-pedagogical experiment is the study of the horizontal and vertical effort by 10-12-year-old rhythmic gymnastics competitors when performing jumps. The contingent of the study was 20 girls engaged in rhythmic gymnastics, aged 10-12 years. The girls are divided into two groups – control and experimental. Both groups train 6 days a week.

METHODS

Testing

Two tests were used to determine the level of the explosive power of the lower limbs – Test 1 "Vertical Jump" and Test 2 "Standing Long Jump".

Figure 1. *Test 1 "Vertical Jump"*

Figure 2. *Test 2 "Standing Long Jump"*

Two more tests were added for comparison with the jump height measured in Test 1 to check the transfer of motor habit – Test 3 "Split Leap" and Test 4 "Turning Split Leap".

Figure 3. *Test 3 "Split Leap"*

Figure 4. *Test 4 "Turning Split Leap"*

Math-statistical methods

- Variation analysis;
- T-criterion of Student;
- Pearson correlation coefficient.

Methodology for developing explosive power of lower limbs

An experimental methodology consisting of 12 exercises for the development of explosive power of lower limbs has been applied for 2 months (3 times a week) upon the experimental group. The set of exercises included long and high jumps, from one and two legs, and the plyometric method was also used. Assistive devices such as a gymnastic chest/bench and rope were used. After each exercise and between sets there are about 40 seconds of rest. The duration of the complex of exercises is about 30 minutes and the number of all jumps is 240. The total number of training sessions is 27. Parental permission and informed consent were obtained from all participants.

RESULTS

Results of Test 1 (Vertical Jump)

For entry and exit testing, two identical tests were used to determine the level of the explosive power of lower limbs. At the beginning of the experiment, data were taken for both experimental and control groups. After we conducted the experiment and applied the prepared methodology, testing was again conducted and the results of the two groups were recorded. The results of each test and each group were examined and analyzed separately. Data for each group are presented in tables.

Table 1. *Variation analysis of the results of Test 1 (Vertical Jump)*

Group	Research	X_{min}	X_{max}	R	X	S	V	As	Ex
Experimental group	Beginning	30	48	18	37.9 0	6.14	16.19	0.226	-1.016
	End	33	50	17	42.2 0	5.55	13.16	-0.007	-1.019
Control group	Beginning	23	45	22	33.5 0	5.68	16.96	0.227	1.961
	End	24	46	22	34.7 0	5.74	16.53	0.101	1.696

In the experimental group, the average value of the "Vertical Jump" test of the subjects in the first examination was 37.90 cm and in the second 42.20 cm (Table 1). The mean value of the Vertical Jump test of the subjects of the control group in the first study was 33.50 cm and in the second study 34.70 cm. The coefficients of variation (V %) indicated that the samples were satisfactorily uniform. When comparing the results of the Vertical Jump test of the two groups, the difference in means in the first study was 4.40 cm and in the second 7.50 cm, both studies were in favor of the experimental group. Empirical data show that the alternative hypothesis is accepted as true – the results and growth in the experimental group are not random, but statistically significant (Table 2).

Table 2. *Statistical significance of the increase in results – Test 1 (Vertical Jump)*

Test 1 (Vertical Jump)	I study		II study		Increment		Statistical significance	
	x_1	S_1	x_2	S_2	d	d%	t^{temp}	α
Experimental group	37.90	6.14	42.20	5.55	4.30	11.35	5.88	0.000
Control group	33.50	5.68	34.70	5.74	1.20	3.58	9.00	0.000

Results of Test 2 (Standing Long Jump)

Table 3. *Variation analysis of the results of Test 2 (Standing Long Jump)*

Group	Research	X_{min}	X_{max}	R	X	S	V	As	Ex
Experimental group	I study	150	190	40	164.50	11.25	6.84	1,294	2,275
	II research	162	202	40	180.60	12.39	6.86	0.296	-0.465
Control group	I study	134	182	48	157.00	14.82	9.44	0.043	-0.522
	II research	136	186	50	159.20	15.69	9.86	0.149	-0.554

In the experimental group on the Standing Long Jump test, the mean value of the subjects in the first examination was 164.50 cm and in the second examination 180.60 cm. The coefficient of variation (V %) shows that the sample is highly uniform (Table 3). The average value of the subjects of the control group at the entrance test was 157 cm and at the exit 159.20 cm. The coefficient of variation (V %) shows that the sample is satisfactorily uniform. The difference in group means in the first study was 7.50 cm and in the second study 21.40 cm, both studies in favor of the experimental group. Empirical data show that the increase of 16.10 cm in the experimental group is statistically significant and the difference can be generalized to the general population (Table 4).

Table 4. *Statistical significance of the increase in results – Test 2 (Standing Long Jump)*

Test 2 (Standing Long Jump)	I study		II study		Increment		Statistical significance	
	x_1	S_1	x_2	S_2	d	d%	t^{emp}	α
Experimental group	164.50	11.25	180.60	12.39	16.10	9.79	4.16	0.002
Control group	157.00	14.82	159.20	15.69	2.20	1.40	5.28	0.001

Results of Test 3 (Split Leap) and Test 4 (Turning Split Leap)

To study and establish the transfer of a motor habit two tests were used – Test 3 (Split Leap) and Test 4 (Turning Split Leap) for comparison with the jump height measured in Test 1 (Vertical Jump). Data were taken only for the experimental group. The aim is to determine at the end of the experiment whether there is a positive transfer of motor habits in the experimental group.

Table 5. *Variation analysis of the results of Test 1, Test 3, and Test 4*

Test	X_{min}	X_{max}	R	X	S	V	As	Ex
Test 1 (Vertical jump)	34	47	13	40.8	4.47	10.95	0.053	-1,461
Test 3 (Split Leap)	33	44	11	38.3	3.77	9.85	0.097	-1.234
Test 4 (Turning Split Leap)	25	40	15	30.8	4.54	14.74	0.883	0.615

From the results of Table 5, we see that in the conducted research the average value of the group in Test 1 (Vertical Jump) is 40.8 cm, while in Test 3 (Split Leap) and Test 4 (Turning Split Leap) these values are lower, respectively 38.3 cm and 30.8 cm. The difference in the average values between Test 1 and Test 3 is insignificant – 2.5 cm, taking into account that Test 1 (Vertical Jump) is performed by two feet bounce and the center of gravity (COG) trajectory is rectilinear, while in Test 3 (Split Leap) it is bounced from one leg and the COG moves along a parabola. Between Test 4 (Turning Split Leap) and the other two tests, we observe a significant difference in the average values of 10 cm with Test 1 (Vertical Jump) and 7.5 cm with Test 3 (Split Leap). Although the execution of the "Turning Split Leap" is closer to the execution of the "Split Leap", with the form of the jump being the same, in both jumps coming off one leg and the COG moving along a parabola, the presence of a rotating movement in the preparatory phase of the first jump significantly complicates its structure and performance technique, which probably 10-12-year-old gymnasts have not yet mastered. The incorrect technical execution of the jumps makes it difficult to realize the maximum explosive power of the lower limbs and we think that this is precisely what is due to the large differences in the average values for the reported jump height between Test 4 (Turning Split Leap) and the other two tests (Test 1 – Vertical Jump and Test 3 – Split Leap).

Table 6. *Correlation analysis of the results of Test 1, Test 3, and Test 4*

Test		Test 1 (Vertical Jump)	Test 3 (Split Leap)	Test 4 (Turning Split Leap)
Test 1	PCC	1		
Test 3	PCC	.861	1	
Test 4	PCC	.617	.899	1

The results of Table 6 show us that the Pearson correlation coefficient (PCC) between Test 1 (Vertical Jump) and Test 3 (Split Leap) is 0.861. This is an indication that the strength of dependence between the performance of these two tests is high and the dependence is upward and statistically significant. With the increase in the explosive power of the lower limbs through the experimental methodology we applied, we observed both an increase in the results in Test 1 and Test 2 during our first study, as well as a positive transfer of a motor habit from "Vertical Jump" to "Split Leap". We see that the Pearson correlation coefficient (PCC) between Test 1 (Vertical Jump) and Test 4 (Turning Split Leap) is 0.617. This shows us that the strength of dependence between the performance of these two tests is significant and the dependence is upward. We attribute the difference in values to the fact that the "Vertical Jump" is a jump with a simpler structure. When performing a "Turning Split Leap" we see that it is difficult for gymnasts to realize their maximum jump height due to the complexity of its technique, and this side of the preparation should be emphasized. Pearson correlation coefficient (PCC) between Test 3 (Split Leap) and Test 4 (Turning Split Leap) is 0.899. This shows us that the strength of dependence between the results of the group in the performance of these two tests is large and the dependence is upward and not random but statistically significant. Since in both jumps – "Split Leap" and "Turning Split Leap" the form of the jump is the same, it is bounced from one leg and the COG moves along a parabola, we believe that it is because of these factors that the values here are approaching and the dependence is great. We attribute the difference of 7.5 cm in the average values to the different complexity of technical execution of the two jumps. During the execution of the "Split Leap" there is no rotational movement, which would make it difficult to realize the accumulated force during the phase of the preparatory actions of the jump. The unmastered technique of performing "Turning Split Leap" is the reason for the unsuccessful realization of the maximum explosive power of the lower limbs by 10-12-yearold gymnasts when performing Test 4.

DISCUSSION

Summarizing the entire study we can draw the following conclusions:

- The developed methodology had a positive impact on the development of the gymnasts. After the sports-pedagogical experiment involving 10-12-year-old gymnasts, the experimental group significantly improved its results – by 4.30 cm in Test 1 and by 16.10 cm in Test 2. We believe that the improvement in the experimental

group is due to the methodology we applied for developing explosive power of the lower limbs;

- We found a different level of explosive power of the lower limbs at the entrance testing of 10-12-year-old girls engaged in rhythmic gymnastics. Both groups were female gymnasts on a 6-day training program but the experimental group performed better in both tests. This is clearly seen from the data from Test 2, where the difference between the groups at the entrance test is 7.50 cm. The difference in the results of the two groups is due to the different methodology used in the sports clubs or the lack thereof;
- We found a positive transfer of motor habit when comparing the results between Test 1 and Test 3. The obtained correlation coefficient of 0.861 proved that the dependence between the jump height of "Vertical Jump" and "Split Leap" is high. The difference in the average values of 2.5 cm in these two tests is insignificant and shows that with the increase in the explosive power of the lower limbs through the experimental methodology we applied the realization of almost the same height is observed in both jumps;
- The analysis of the results shows that the experimental methodology we developed and applied in this study works and can be used in coaching practice. In the experimental group at the end of the experiment, we began to observe adaptation to the training load when performing the methodology. This allows changes to be made regarding its volume in order to be effective;
- We appeal to all practicing coaches with the recommendation to regularly test their gymnasts and monitor their physical development so that timely adjustments can be made to their training plan. It's also important to not only prioritize work on single motor quality but at the same time pay attention to the development of the other physical qualities which are just as significant.

REFERENCES

Atanasova, Tsv., Shishkova, T. (1989). *Rhythmic gymnastics*, *VIF*, Sofia.

Bachev, V. (2017). *Osnovi na nauchnite izsledvnia v sporta, NSA PRES*, Sofia.

Bachvarov, M. (2000). *Sportologiy*, *NSA PRES*, Sofia.

Gantcheva, G., M. Gateva (2017). *Hudozhestvena gimnastika – 60 godini nauka*, *NSA PRES*, Sofia.

Gantcheva, G., Ivanova, V. (2017). *Testove za kontrol i ocenka na fizicheskata podgotovka po hudozhestvena gimnastika*, Bolid Ins, Sofia.

Gigova, V., Damianova, R. (2020). *Statisticheski metodi v sporta*, *NSA PRES*, Sofia.

Hadzhiev, N. et al. (2011). *Fizicheska podgotovka,* NSA PRES, Sofia.

Hadzhiev, N., Andonov, K., Dimitrova, B. (2011). *Selekcia na talantite v gimnasticheskite sportove*, NSA PRES, Sofia.

Hadzhiev, N., Andonov, K., Sergiev, G. (2010). *Periodizacia i planirane na trenirovachnia proces v gimnastikata,* NSA PRES, Sofia.

Hadzhiev, N., Andonov, K., Mineva, M. (2011). *Kontrol na sportnata trenirovka v gimnastikata*, NSA PRES, Sofia.

Karpenko, L., Rumba, O. (2014). Teoria i metodika fizicheskoi podgotovki v hudojestvennoi i esteticheskoi gimnastike, *Sovetskiy sport*, Moskva.

Makenzi, B. (2011). *101 Testa za ocenka na fizicheskata godnost, NSA PRES*, Sofia.

Matveev, L. (1977). *Osnovyi sportivnoi trenirovki*, *FiS*, Moskva.

Mihaylov, M., Andonov, H. (2016). *Teoria i metodika na sportnata trenirovka*, Bolid Ins, Sofia.

Mineva, M. (1986). Optimizirane na metodite za kontrol i ocenka na dvigatelnoto kachestvo gavkavost pri 9-13-godishni gimnastichki i usavarshenstvane na negovoto razvitie, *ETSNPKFKS*, Sofia.

Pirovska, M., G. Nedialkova (1986). *Edinna programa po hudojestvena gimnastika*, *BSFS*, Sofia.

Vankov, I. (1982). Izsledvane na fizicheskata podgotovka na sastezatelki po hudozhestvena gimnastika i usavarshenstvane sistemata za control, ocenka i optimizirane, Disertation, VIF, Sofia.

Zheliazkov, Tsv., Dasheva, D. (2017). *Osnovi na sportnata trenirovka*, Bolid Ins, Sofia.

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INDICATORS FOR THE EFFECTIVENESS OF THE SPORTS TRAINING OF THE ALPINE SKIER IN THE PREPARATION PERIOD

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ABSTRACT
The planning of the training process leads to an increase in the level of the alpine skier and in the first place it is an indicator of the effectiveness of the training. In the practice of skiing, the control of special physical training is widely used. The conducted field tests provide information on each side of the alpine skier's training, which meet the training requirements of the competitors. This is our main goal in this study. The approbation of specialized tests for assessment of the specific working capacity and optimization of the training loads is our main task. Functional method (medical-biological) and sports pedagogical method - (field) appear as the most accurate criteria for assessing the current state of the alpine skier in the preparatory period. The functional method (KFI) gives an assessment of the specific training of the competitors. The sports-pedagogical method determines the current state and gives an assessment of the potential of the competitors. The need to increase the efficiency of the training process requires the introduction of new indicators that will give a better assessment of the athletes and their current condition in the preparation period. Such results were a 400m run, 40 cm box jump, and contact platform. Optimizing the effect of training with the help of tests that carry quantitative information about the individual factors influencing the sports result.

Keywords*: alpine ski, training, planning, control*

INTRODUCTION

Planning the training process in alpine skiers is a decisive factor in achieving high sport results. The right approach leads to an increase in the level of preparation of the athlete and in first place is an indicator of the effectiveness of sport training. In the practice of skiing, the assessment is widely used for physical fitness based on growth of Specific physical training – General physical training (SPT – GPT).

This assessment also formed with the help of various motor activities and exercises that imply the reflection of the level of development of the basic physical qualities of the alpine skier. Competitions are an integral and important part of sports activity. In the process in their preparation, competitors are directed in two main directions: on one hand, participation in competitions, which leads to an increase in the level, and on the other hand, as a means of checking the effectiveness of pre - season training. All this gives reason to consider that the competition period is the main and leading one in the annual cycle. In the modern conditions of increasing the quality and effect of sports training of professional alpine skiers, changes are necessary, with the main priority being the improvement of sport results and prevention. One of the most important means of solving this problem is focused on reporting the individual and functional reserve of the organism capacity (Shaposhnikova, 2001; Denisenko, 2002; Bogdanov, 2003; Fomin, 1893).

Analyzing specialized scientific and methodical literature, it shows that the main factor that can ensure the growth of results is a gradually improved methodology of sports training, which allows reaching maximum values of the volume and intensity of the load.

The need to increase the efficiency of the training process requires the implementation of new indicators in the planning system. Therefore, it is very important that planning relies on objective and informative indicators of the training process. The training programs are based on the basic movements with a special cyclic nature. The different nature of the load with such means is closest to the physiological essence of skiing disciplines. The various profiles educate the specific pace and rhythm of the movements, the overcoming of heights and the correct combination of the work in the different sections by profile (Zografov, 2011).

Controlling the functional status of athletes is essential for planning and managing the training-competition process. The periodic conduct of control functional studies brings information about the adaptation of the athletes to the load specific to the given sports discipline and the functional capabilities and reserves of each individual competi-

tor. Zv. Zhelyazkov (2009) defines maximal oxygen consumption as an indicator of the level of training in endurance sports and criteria for predicting sports performance.

The morphological characteristics of the skiers largely determine the physical state of the body's reaction to the training process, recovery and the impact on the manifestation of the skiers' motor abilities. Among the many morphological parameters, special attention is paid to indicators such as: total body size, proportions and body weight. The study of anthropometric indicators makes it possible to assess the level of physical development.

Pedagogical control from the point of view of the theory and methodology of the training process is the development of means and methods for obtaining information, checking the correct impact, aimed at increasing the effectiveness of the training work of alpine skiers. The indicator of sports readiness is a quantitative characteristic of the athlete's properties that are part of his preparation, considered and related to a certain training and competitive activity. The identification and measurement of such indicators, the formation of assessments of physical fitness are one of the crucial tasks for achieving high results in the training of skiers. From the literature review, we believe that the problem regarding the main indicators of training load and control - testing in the preparatory period of the annual cycle is relevant and its research would lead to the improvement of sports results in alpine skiing disciplines.

For this purpose, we performed an analysis of the training load in the preparatory stage and the main indicators from the tests of the Bulgarian competitors in alpine skiing disciplines. In accordance with the objective thus set, the following tasks were defined:

- To compare and analyze the dynamics of the total volume of the training load in the preparatory period of the annual macrocycle.
- To compare and analyze the distribution of the training load by training means (general and specific) in the preparatory period.
- establishing the indicators and parameters characterizing the main factors of sports achievement;

MATERIAL AND METHODS

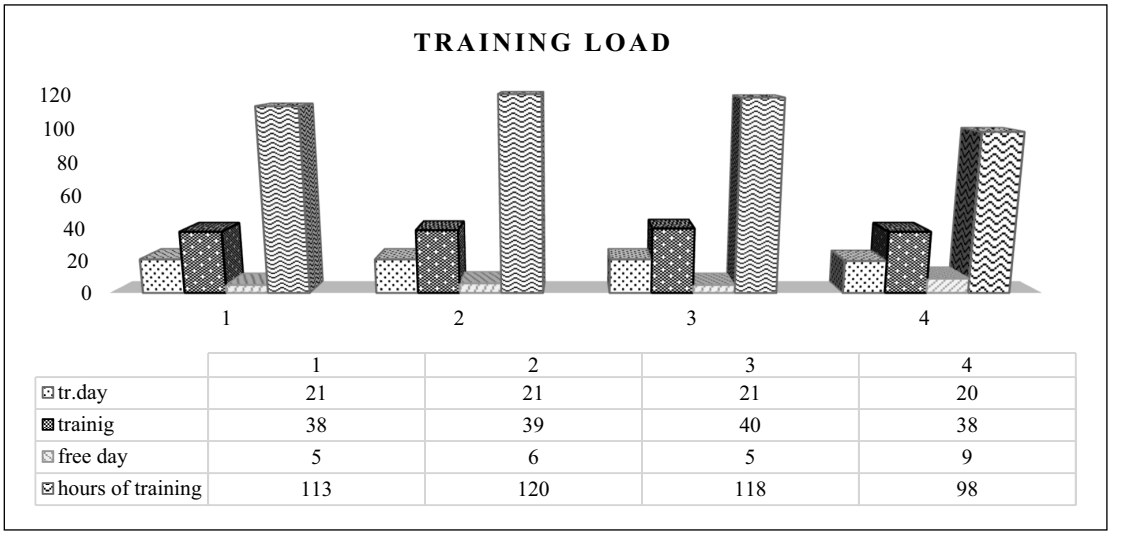
The object of the present research are the control tests of the Bulgarian athletes in alpine skiing disciplines, and the subject - their specific training indicators.

Optimizing the effect of the training with the help of tests that carry quantitative information about the individual factors influencing the sports result is considered as optimizing a certain part of the management of the training activity. This gave us the basis to formulate the THESIS that the periodic application of tests is a highly effective method for tracking the dynamics of adaptation processes and changes in efficiency in the preparatory period of the training process, as well as for individual evaluation, control and optimization of training and competition loads.

Subjects of the research are alpine skiers from Bulgaria. The main work carried out during the research is a thorough analysis of the plans-programs of the national team in alpine skiing disciplines and an analysis of the results obtained from the control tests conducted during the preparatory period. We analyzed the training plan and specifically the general and specific training indicators, determining the ratio of the main parameters of the training load. Based on the control tests carried out, we performed an analysis of the indicators to give us an assessment of the work during the preparation stage. This is also the end of this mesocycle of the preparation of the national competitors. In accordance with the set goal and tasks, we applied the following traditional research methods: Study of the scientific-methodical literature, Analysis of training plans-programs and the translated sports pedagogical tests, targeted pedagogical observation of the training process.

RESULTS

The planning of training loads in the preparatory period for alpine skiers revealed the characteristics of the application of means, volume and intensity of the load aimed at the development of physical qualities, taking into account the results of research conducted at the beginning of the preparatory period. the analysis and interpretation of the studies of athletes and coaches was taken into account to identify the most common means, methods and their ratio in the preparation of alpine skiers in the stages of the preparatory period. the data obtained from the tests are taken into account in the planning of microcycles in the preparatory period, cyclic load, as well as the degrees of intensity.



	1	2	3	4
tr.day	21	21	21	20
trainig	38	39	40	38
free day	5	6	5	9
hours of training	113	120	118	98

Figure 1. *Dynamics of training load by mesocycles*

Figure 1 presents information on the total load in the mesocycles of alpine skiers. What is striking is that in mesocycles one (June), two (July) and three (August) of the general preparatory stage, as well as in the fourth (September) of the special preparatory stage, the largest volume of work was carried out in terms of hours. In this way, the basic principles in programming the training process in the annual cycle have been observed. The main task in the basic mesocycle (June) was to create a "foundation" of special physical training, improving general and special strength endurance. It should be noted that after the training load, a set of exercises was performed to develop flexibility. The main task of the building mesocycle (July) is to raise the level of special physical training. Examining the characteristics of this mesocycle, we recommend performing load-developing volumes up to 40% of the total volume. In this mesocycle, the proportion of loads performed at a high intensity increases. The tasks of the mesocycle (September) were aimed at maintaining the achieved level of special physical training.

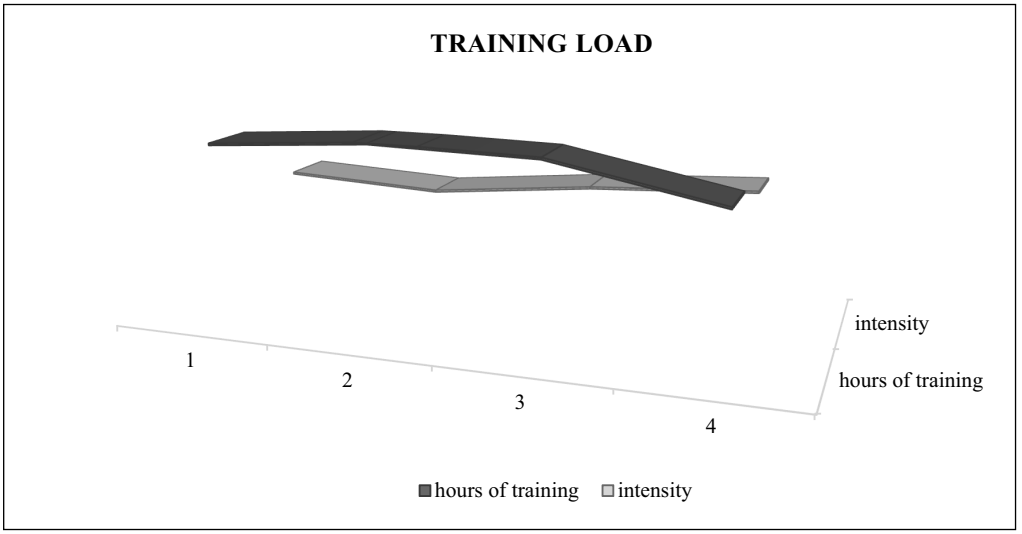
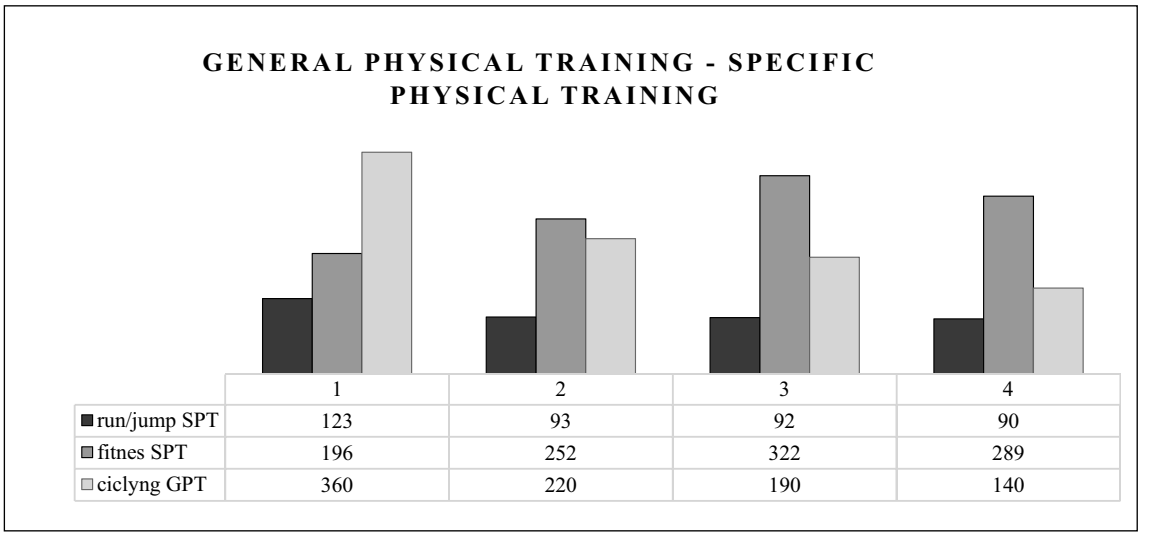


Figure 2. *Dynamics of training load in alpine skiers*

In Figure 2 the main trend in the load dynamics during the special preparatory stage is presented. Reducing the total volume of training hours and further increasing the intensity of training work solves the problem of special and speed-power endurance. The intensity of the load leads to a better long-term adaptation of the processes connected with the mechanism of the "delayed transformation" (Mat-

veev, 1977). Therefore, reducing the load volume and correspondingly increasing the intensity leads to a sharp increase in functional indicators. If this is not achieved, there is a real danger that the preparatory period will remain incomplete. The main tasks were aimed at increasing the level of development of special endurance, speed-power abilities as a limiting factor of speed; higher level of SPT; achieving and maintaining a high level of functional fitness. Great attention was paid to speed and strength training.

SPT – Specific Physical Training; GPT – General Physical Training



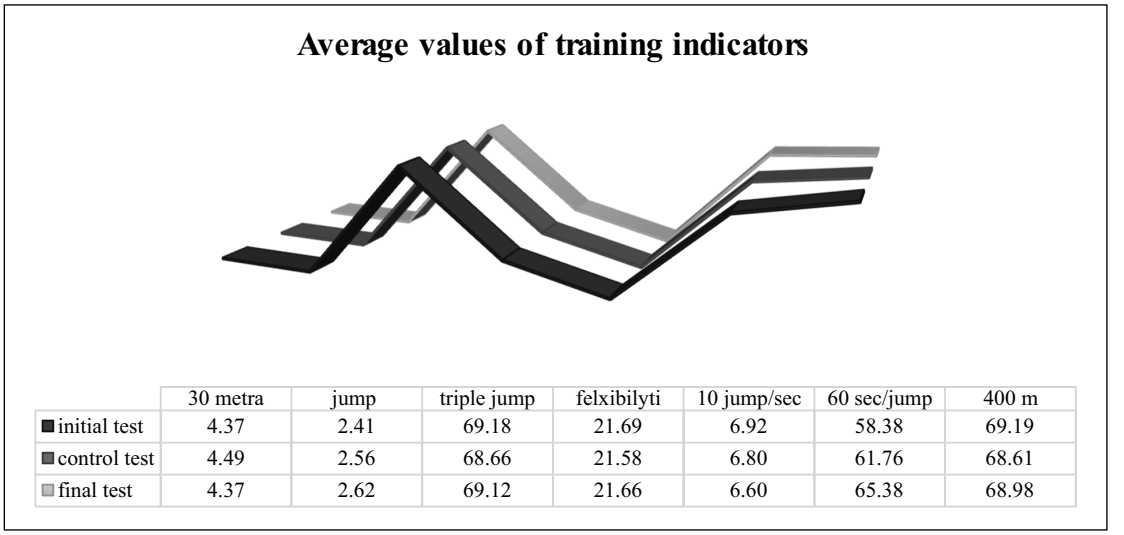
	1	2	3	4
run/jump SPT	123	93	92	90
fitnes SPT	196	252	322	289
ciclyng GPT	360	220	190	140

Figure 3. *Ratio of training means in alpine skiers*

In Figure 3 we have looked at the ratio of training means in alpine skiers. We report a large increase in the specific physical training in the 3rd and 4th microcycle of the preparatory stage by more than 126 points. In the subsequent microcycles, there is a decrease in the volume of run/jump SPT, which is accompanied by a change in intensity.

The dynamics of the intensity was reflected in Figure 2. In the first microcycle, tests were carried out, the tasks of which were to check the effectiveness of the completed training work during the stage; to reveal the level of physical fitness of alpine skiers to plan training loads for the next stage. In the second microcycle, control trainings took place. The tasks related to the distribution of forces during the tests were solved. Training loads were performed using the interval, variable and circuit method.

The recovery microcycle is the end of the special preparatory stage of the training of cross-country skiers. Special attention was paid to the SPT at the end of the preparatory stage, which solved our tasks of achieving and maintaining a high level of functional training. Taking into account the above, we come to the conclusion that the improvement of the structure of the training load is particularly interesting in its part of increasing the efficiency of the training process. This is related to the need for a scientifically and experimentally based system for planning and controlling the competition and training load in the annual cycle of alpine skiers, especially in the competition period and stage of immediate preparation for competitions. Informative indicators of the skiers' readiness are the results of the following tests: sprint 30 m; standing jump and triple jump; box jump 40 cm for 10 sec. and 60 sec. for max hop count; 400 meters. These tests are objective criteria for the selection and orientation of athletes in the training and competition period.



	30 metra	jump	triple jump	felxibilyti	10 jump/sec	60 sec/jump	400 m
initial test	4.37	2.41	69.18	21.69	6.92	58.38	69.19
control test	4.49	2.56	68.66	21.58	6.80	61.76	68.61
final test	4.37	2.62	69.12	21.66	6.60	65.38	68.98

Figure 4. *Average values of training indicators*

Figure 4 presents the average values of the indicators from the tests of the national team in alpine skiing disciplines. The initial test was done at the beginning of the preparatory stage. The control test was done at the end of the 2nd microcycle (July). The final test of training indicators at the end of 3rd microcycle (August). Significant changes are reported in the final results of the achieved results. When comparing the initial and final testing results, we see that there is an improvement in the average indicators in each of the conducted tests of the training indicators. In the 30 m test - characterizes the skier's running speed, there is no difference in the initial and final test.

The indicator jump from a place - test gives information about the explosive power of the legs, the average value difference from the initial and final test is 0.21 cm. In the triple jump (characterizes the skier's speed-power capabilities) and flexibility (estimation of elasticity, mobility of the body) as indicators we have no improvement in the values from the initial and final conducted test. The biggest improvement in the test conducted on a 40 cm box (characterizes the speed-power character), the average value is 7.00 pcs. In the 400m indicator (the overall endurance of the skier as well as the connection with the will endurance) the average value is improved by 0.21 sec. This is not accidental, because above in the analysis of the training equipment, the work for speed-power endurance can be seen in the last 2nd microcycles of the preparatory stage.

DISCUSSION

The identification and measurement of such indicators, the formation of assessments of technical and tactical skills are one of the crucial tasks for achieving high results in the training of skiers. The effectiveness of actions is based on their efficiency and economy. As a result of the work, the qualities that, in our opinion, determine the success in the technical disciplines of the studied Alpine skiers were revealed. To ensure growth in preparation, it is necessary to develop and improve the specific qualities of skiers: speed, agility, strength, endurance, a specific sense of balance, specific properties of visual and kinesthetic analyzers, specific courage, determination, etc.

We also emphasize the importance of using a diverse complex of physical exercises in the preparatory period, which include exercises for general development and various types of sports. Special exercises solve the problem of special physical training and develop the necessary technical and tactical skills. Staged control testing of skiers, by means of systematic pedagogical and medico-biological tests, enables an objective assessment of the readiness of athletes and provides an opportunity for effective management of the training process. At the same time, relevance in alpine skiing rests on research that has already been done and demonstrates the correlation between the results of individual competitors at a high elite level.

A large part of these systematized results can serve as a reference point for the study of training indicators and conditioning in coaches working with athletes in alpine skiing disciplines. Also to build a test battery at a new level, which can more precisely give a picture of the physical condition of skiers on the one hand, and to improve their level of performance on the other.

REFERENCES

Fomin, B.C. (1983). Kompleksen podhod kum otsenkata na funktsionalnata podgotovka na sportistite, *sbornik nauch. Trudove*. //Фомин, В.С. (1983). Комплексный подход к оценке функциональной подготовленности спортсменов, сборник науч. трудов.

Matveev, L.P. (1977). *Osnovi Sportivnoĭ Trenirovki. Fizkultura i sport*, 280 s //Матвеев, Л.П. (1977). Основы Спортивной Тренировки. Физкультура И Спорт, 280 с.

Platonov, V.N. (1984). *Teoriya I Metodika Sportivnoi Trenirovki*, Vishta shk , 336 s.// Платонов, В.Н. (1984) Теория *и* Методика Спортивной Тренировки, Вища шк. 336 с.

Platonov, V.N. (1995). *Struktura mnogoletnego i godishno postroenie podgotovki* // Sovremennaya sistema sportivnoy podgotovki. - M.: SAAM, // Платонов, В.Н. (1995). Структура многолетнего *и* годичного построения подготовки // Современная система спортивной подготовки. - М.: СААМ.

Verkhoshanskiĭ, YU.V. (1988). *Osnovi na Spetsialnata Fizicheska Podgotovki Sportsmenov*. Fizkultura i sport,.// Верхошанский, Ю.В. (1988). Основы Специальной Физической Подготовки Спортсменов. Физкультура И Спорт.

Verkhoshanskiy, YU. V. (1977). *Osnovy spetsial'noy silovoy podgotovki v sporte.* - M.: Fizkul'tura i sport, 214 s.// Верхошанский, Ю. В. (1977). Основы специальной силовой подготовки *в* спорте. - М.: Физкультура и спорт. 214 с.

Verkhoshanskiy, YU.V. (1988*). Osnovy spetsialnata fizicheskoy podgotovki sportsmenov.* FiS,. - 331 s.//Верхошански, Ю.В. Основи на специалната физическа подготовка на спортисти. FiS pp. 331

Zhelyazkov, Ts., Dasheva, D., Neykov, S. (2020). *Osnovi na sportnata trenirovka*, BOLID-INS, Sofia, c. 249. // Желязков, Ц., Дашева, Д., Нейков, С. (2020). Основи на спортната тренировка, БОЛИД-ИНС, София, с. 249.

Zografov, P. (2011). *Osnovi na sportnata trenirovka na elitni skiori begachi,* NSA PRES, Sofia, s. 107. // Зографов, П. (2011). Основи на спортната тренировка на елитни скиори бегачи, НСА ПРЕС, София, с. 107.

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EFFECT OF AN EXPERIMENTAL TRAINING MODEL ON MOTOR ABILITIES DEVELOPMENT AND AEROBIC CAPACITY IN PEOPLE PRACTICING FUNCTIONAL TRAINING

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ABSTRACT

There is a current interest in optimizing the training load, which is expressed on the one hand in an increased degree of adaptation to physical exercises, and on the other - reducing the time for their implementation.

The aim of the present study is to monitor changes in the level of development of motor abilities and the level of development of aerobic capacity in women and men practicing functional training through an experimental training model.

Methods: The experiment involved 23 people (10 men and 13 women) practicing functional training. Within the 10-week period, they performed an experimental training model combining circuit training and Tabata protocol. We measured the physical fitness indicators by means of an adapted "Eurofit" battery, and the aerobic capacity of the participants by means of "Beep test".

Results: We report positive changes in the measured indicators of physical fitness and more significant improvements in the strength endurance of the upper limbs and abdominal muscles, explosive force of the lower limbs, and aerobic capacity.

Conclusion: Our proposed experimental training methodology, applied for a period of 10 weeks has led to an improvement in functional capacity in women and men practicing functional training.

Keywords*: HIIT, circuit training, Tabata protocol, physical fitness, aerobic capacity*

INTRODUCTION

The interest in optimizing the training load is quite topical. The training load is an increased degree of adaptation to physical exercises and a reduction of the time for their execution. Modern trends aim to realize training loads engaging the muscles of the whole body, executed for a short time.

Circuit training is a kind of conditional training, including endurance load, resistance exercises, and high-intensity aerobic activities. It is aimed towards the development of muscle strength and endurance. The exercises in a circuit range from 4 to 15 and are usually executed within 30-90 sec in combination with 30-90 sec breaks. Depending on the training objective, the exercises can be executed for a particular time or until an athlete reaches a certain number of repetitions. The circuits in a training session range from 1 to 3 with 2-3 min breaks (Comyns, 2018). The consecutive work of different muscle groups within a circuit ensures their more extended recovery period until the beginning of the next circuit, which benefits their recovery and efficiency (Fitzgerald, 2011). They are an efficient and economical way to improve the cardiovascular system and muscle endurance (Heaven, Colman, 2004; Klika et al., 2013).

In 1980, sports specialists emphasized the anaerobic profile of high-intensity interval training sessions through a quantitative indicator of the accumulated oxygen deficit measured during training sessions. This aspect was effectively proven and used by Tabata et al. (Tabata et al., 1997). The training sessions led to the simultaneous development of the anaerobic capacity and VO_2max (Tabata et al., 1996). Modern surveys have established an expressed adaptation of the skeletal muscles and an increase of VO_2max with 9,2% due to the Tabata method application (Miyamoto-Mikami et al., 2018). The increase in VO2max after Tabata method training sessions can be seen after only 2-3 weeks (Tabata et al., 1996; Hirai & Tabata, 1996). This positive adaptation is due to peripheral factors because morphological changes in the heart muscle require a significantly longer time (Kenny et al., 2012; Viana et al., 2019). A characteristic of the Tabata method is the ratio between work periods and periods of rest, which is always 2:1. A constant intensity of the training load is maintained (170% of VO_2max), and the break is passive (Tabata, 2019).

Aim and objectives of the study

This experiment aimed to trace the change in the level of the development of the motor qualities and aerobic capacity of men and women practicing functional fitness loads through the suggested experimental model of a training load.

STUDY DESIGN

The participants in this research followed the created by us experimental training method for 10 weeks (Table 1).

Table 1. *Weekly training split*

Day of the week	Kind of Training
Monday	Circuit functional training
Tuesday	Tabata protocol training
Wednesday	Rest
Thursday	Circuit functional training
Friday	Tabata protocol training
Saturday	Rest
Sunday	Rest

The experimental training method unites circuit training and Tabata protocol. Each training session starts with 8-10-min warmup exercises – a general warmup, running, and jumping exercises. During the cool-down, static stretching exercises are performed for 8 to 10 min. The ratio between work and rest intervals is 2:1 (40:20 sec for the circuit training and 20:10 sec for Tabata protocol). The rest is passive with both loads. During the work interval, athletes should perform a maximum number of repetitions. They perform three circuits with a 2-min rest in between. Each training session aims at a complex load of muscle groups of the whole body, emphasizing the development of strength and personal strength abilities.

The circuit training session includes ten exercises – front squats, pull-ups with a wide grip, stepping on an elevated surface (plyo box), barbell rows, dumbbell lifts from a supine position, bench dips, military press, lateral dumbbell pulls, and up-down planks.

The Tabata training consists of 6 stations. Each of these includes 2 exercises which repeat four times, with work and rest intervals of 2:1. After a minute break, athletes move on to the next station: 1. Kettlebell swings - Jumping Jacks; 2. Dynamic lunges - Jump squat; 3. Dumbbell rows – Burpee; 4. Push-ups - Sit-ups; 5. Biceps curl with bands - Triceps extension with bands; 6. Stepping on and getting off a box - a medicine ball throws at a wall.

The two genders use different weights for the execution of each exercise. Prior to the beginning of the experiment and after the ten-week experimental training model, we tested the level of development of motor qualities and the aerobic capacity of each participant in the research.

RESEARCH METHODS

The adaptation of skeletal muscles (strength endurance and speed endurance) as a result of the application of the experimental training model was established through the changes in the level of development of motor qualities, which we tested with a united test battery created for the aims of the research (Table 2).

Table 2. *United test battery for evaluation of physical ability and aerobic capacity (Eurofit, 1993; Leger et al., 1988; topendsports.com).*

Tested quality	Reported Characteristic	Time/Number	Test contents
1. Endurance	1. Cardio-respiratory endurance/speed endurance 2. Strength endurance of abdominal muscles 3. Strength endurance of the upper body	 For 1 min For 1 min	1. **Beep test**[2] 2. Raizing the torso from a supine lying position[1] 3. Push-ups[3]
2. Strength	1. Static strength 2. Explosive power of lower limbs	The best of two maximal contractions is recorded	1. Hand dynamometric[1] 2. Long jump from a standing position[1]
3. Velocity	1. Speed abilities		**Beep test**[2]
4. Flexibility	The flexibility of the spinal column	The best of two attempts is recorded	Forward bend from sitting position[1]
5. Balance	Body Balance	The best of two attempts is recorded	Balance on support on one foot[1]

Legend: 1 - Eurofit, 1993, 2 – Leger et al, 1988, 3 - topendsports.com

The changes in the aerobic capacity were recorded with a 20m Beep endurance test (Leger et al., 1988). The test is used to evaluate cardio-respiratory abilities of athletes of all age groups who train purposefully. 20m Beep test is in the group of terrain tests, performed until failure. It is held along a preliminarily marked with a cones distance of 20 m. The test includes 21 levels, and each level has a duration of 60 sec. For this time, the researched individual should make a certain number of shuttles. The test begins at 8 km/h, and the speed increases with 0.5 km/h at every subsequent level, which is one minute long. Athletes are told to maintain the speed set by the software. There is a failure when the researched individual falls behind two times in a row for more than two meters at the sound signal on both end lines, i.e., the athlete cannot adapt to the gradually increased running speed. The indicators provided by the test are running speed along the distance, time, maximal oxygen intake (VO_2 max), level, and a number of shuttles per level. VO_2max is calculated with the following formula:

VO_2 max= 3.46x (1x stage+ (marker/ (stage x 0, 4325 + 7.0048))) +12.2

where stage – achieved a level in a test; marker – number of shuttles in the achieved level, VO_2 max – maximal oxygen intake.

The results are calculated with a software formula developed in previous research (Kolimechkov et al., 2017).

Standard tables for the evaluation of researched indicators

Table 3. *Standardized table of test battery "Eurofit" for evaluation of male and female physical ability (after Eurofit, 1993)*

Indicators	Arm strength (kg)		Long jump (cm)		Raising the torso from a supine position (cm)		Flamingo test (cm)		Flexibility (cm)	
Evaluation	M	F	M	F	M	F	M	F	M	F
Excellent	over 60	over 37	over 252	over 187	over 32	over 26	0	0	over 20	over 18
Very good	57-60	33-36	241- 252	175- 186	31-32	24-26	5-1	1-0	19-27	13-18
Good	48-56	27-32	219-240	152-174	27-30	20-23	7-5	3-1	6-19	2-12
Average	43-47	23-26	208-218	140-151	23-26	16-19	10-8	5-3	-2-+5	-4-+1
Poor	under 43	under 23	under 208	under 160	under 23	under 16	over 11	over 5	under -2	under -4

Table 4. *Push-up test norms for MEN and WOMEN (Push-up test at home)*

Evaluation	Men	Women
Excellent	> 41	> 28
Good	34-41	21-28
Above average	25-33	13-20
Average	13-24	7-12
Below average	8-12	3-6
Poor	2-7	1-2
Very Poor	< 2	0

STATISTICAL ANALYSES

We used Student T-test and Wilcoxon test for the analysis for two dependent samples. The statistical processing of the data was done with the software package SPSS V.25. The accepted statistical significance level was $\alpha = .05$. We use Cohen's d to the effect size of development in each physical fitness component.

Paired-Samples T-test is a test for the comparison of parameters with normal distribution. We used it to compare the means of some physical fitness components. For parameters with abnormal distribution, we used Wilcoxon signed-rank test to compare the mean difference. Statistically significant differences between the mean values were evaluated at $p < .05$, and all data in the text were presented as mean ± SD.

RESULTS

The research was done in the period 24 January – 1 April 2022 on the premises of "X Fit Club" in the town of Plovdiv. Ten men and 13 women practicing functional training in recent years took part in the experiment (Table 5).

Table 5. *Basic data about the participants in the experiment*

	Men	Women
Age	37.40 ± 9.82	34.92 ± 8.40
Stature (cm)	176.9 ± 7.74	165.08 ± 5.51
Sports experience (years)	2.74 ± 1.77	3.18 ± 1.85

Analysis of the changes in the indicators for physical ability

The push-ups and sit-ups test among men showed statistically significant differences along both indicators (Student T-test Sig=.000<.05) with a large effect size (Cohen's d >.80). The number of push-ups (Table 6) increased from 35 at the beginning of the test to 43 (25%) at the end of the experiment. The average evaluation almost reached Excellent (Table 3). The test measuring the strength endurance of core muscles also showed positive dynamics (Table 6). The indicator increased with 6 repetitions (20%), and the average evaluation from Very Good in the beginning reached Excellent in the end (Table 3). There was a reliable increase in the indicators in the tests measuring the flexibility of the spinal column and the explosive power of lower limbs (Table 6) – Wilcoxon Sig = .012 < .05, with a large effect size (Cohen's d > .80). In the test Forward Bend from a Sitting Position, the measured indicator increased by 7 cm, and the evaluation increased from Average to Good (Table 3). In the Long Jump test, the measured indicator increased by 12 cm, and the evaluation increased from Poor to Good (Table 3). The test Hand Dynamometry which measured the static strength of the grip of both hands also showed positive changes with a large effect size (Cohen's d > .80). There was a reliable increase in the strength of the right hand (Student T-test Sig = .002 < .05) with 7 kg (13%), and the left hand – with 4 kg (10%), where there were also reliable differences (Student T-test Sig= .012 < .05). The average evaluation of both tests increased from Good to Very Good (Table 3).

Similar to the researched men, the researched women also showed positive changes along all indicators, measuring the level of development of motor qualities. In the tests Push-ups and Sit-ups, measuring the strength of upper limbs and core muscles, there were positive reliable differences at the end of the experiment (Student T-test Sig = .000 < .05) with a large effect size (Cohen's d >0.80). The number of push-ups (Table 6) increased from 26 at the beginning of the test to 34, and the average evaluation increased from Very Good to Excellent (Table 3). The number of sit-ups (Table 6) increased with 6 repetitions, and the average evaluation increased to Excellent in the end (Table 3). There was

a reliable increase in the indicators in the tests Forward Bend from Sitting Position – with 4 cm, and Long Jump – with 15 cm (Table 6) – Student *T*-test Sig = .026 < .05, with a large effect size (Cohen's *d* > .80). The evaluation of the Long Jump increased from Average to Good. Of Forward Bend from Sitting Position it remains in the range of Good (Table 3). The strength of the right hand (Table 6) showed a reliable increase (Wilcoxon Sig= .023 < .05) with 1 kg, and the strength of the left hand (Table 6) – with 2 kg (Student *T*-test Sig = .003 < .05), again with a large effect size (Cohen's *d* > .80). The average evaluation of the left hand increased from Average to Good. The evaluation of the right hand remains in the range of Good (Table 3).

The test Flamingo, measuring the body balance, showed very good results at the start of the experiment and did not show any statistically significant differences after the end.

Table 6. *Changes in average values of researched indicators for the participants in the experiment*

Researched indicator	Men			Women		
	Beginning	End	P Value	Beginning	End	P Value
Push-ups	35.40±12.52	43.30±11.96	.000	25.92±13.31	34.38±1.09	.000
Sit-ups	29.60±6.96	35.70±7.27	.000	26.69±6.45	32.46±6.31	.000
Forward bend from sitting position	102.00±6.85	109.30±9.53	.012	102.38±13.19	106.62±9.22	.026
Long jump	199.20±2.25	211.70±6.74	.012	153.38±19.09	168.46±18.16	.026
Hand dynamometry – left hand	46.41±1.52	5.63±1.34	.012	26.15±3.15	28.16±2.24	.003
Hand dynamometry – right hand	47.90±12.33	54.44±11.83	.002	29.23±3.45	3.95±3.86	.023

Analysis of the results of the changes in aerobic capacity

The changes in the aerobic capacity of the researched individuals were recorded with the application Beep test (Leger et al, 1988), which substituted the shuttle run from the test battery Euro fit.

The comparative analysis of the results from the test for determining the aerobic capacity among men revealed significant changes (Table 7). Men's weight decreased by 1.8 kg without a statistically significant difference. The oxygen intake had a reliable statistical increase from evaluation Average to evaluation Good (Kolimechkov et al., 2017). As a result of the mentioned sports-physiological changes, the percentile evaluation also changed: from 62.1 percentile, it increased to 80.4 percentile. As a result, we can conclude that the researched men overtake 80 percent of the cases for this age. The quality equivalent of the evaluation is the change from Average to Good (Kolimechkov et al., 2017).

Table 7. *Changes in the aerobic capacity after application of 10-week experimental methods among men (n=10)*

Parameter	Mean (±)	Student t-test	Cohen's d
Weight (beginning)	82.2±17.8	.054	1.60
Weight (end)	8.0±15.8	.054	1.60
Level (beginning)	5.2±1.6	.017*	0.99
Level (end)	7.0±2.1	.017*	0.99
Distance (beginning)	773.3±273.8	.009**	1.15
Distance (end)	1131.1±374.4	.009**	1.15
Speed at failure (beginning)	1.6±.8	.017*	0.99
Speed at failure (end)	11.5±1.0	.017*	0.99
VO_2 max (ml/kg/min) (beginning)	4.5±4.1	.006**	1.21
VO_2 max (ml/kg/min) (end)	45.7±5.5	.006**	1.21
Percentile evaluation (beginning)	62.1±3.6	.03*	0.87
Percentile evaluation (end)	8.4±21.0	.03*	0.87

Legend: Statistical significance level α = 0.05*; *Statistical significance level* α < 0.01**; *Effect size Cohen's d: 0.3 trivalent; 0.5 average; over 0.8 large effect.*

The comparative analysis of the results from the test for determining the aerobic capacity of the women who took part in the experiment is presented in Table 8.

Women's weight showed a statistically reliable change over the research period. The average reduction in weight for the group of the women was 2.6 kg, and these values fall within the frame of healthy weight loss.

The aerobic capacity was determined with software (Kolimechkov et al., 2017). The increase of VO_2max from 37.7 to 40.9 ml/kg showed statistical significance $\alpha < .01^{**}$. The quality evaluation changed from Good to Excellent (Kolimechkov et al., 2017).

As a result of the mentioned sports-physiological changes, the percentile evaluation also changed – from 87.2 percentile, it increased to 91.6 percentile, which showed that after the experiment, the researched women overtook 91 percent of the cases for this age. The quality equivalent of the evaluation is the change from Good to Excellent (Kolimechkov et al., 2017).

Table 8. *Changes in the aerobic capacity after the application of 10-week experimental methods among women (n=13)*

Parameter	Mean (±)	Student t-test	Cohen's d
Weight (beginning)	68.1±12.2	.029*	1.60
Weight (end)	65.5±11.6	.029*	1.60
Level (beginning)	4.4±1.6	.002**	0.99
Level (end)	5.5±1.9	.002**	0.99
Distance (beginning)	623.1±262.6	.002**	1.15
Distance (end)	835.4±389.4	.002**	1.15
Speed at failure (beginning)	10.2±0.8	.002**	0.99
Speed at failure (end)	10.7±0.9	.002**	0.99
VO_2 max (ml/kg/min) (beginning)	37.7±4.3	.001**	1.21
VO_2 max (ml/kg/min) (end)	40.9±6.0	.001**	1.21
Percentile evaluation (beginning)	87.2±9.9	.026*	0.87
Percentile evaluation (end)	91.6±7.8	.026*	0.87

Legend: Statistical significance level α = 0.05; Statistical significance level α < .01**; Effect size Cohen's d: 0.3 trivalent; 0.5 average; over 0.8 large effect.*

DISCUSSION

After the end of the experiment, there was a statistically significant increase in all indicators for physical ability, measured with the applied united test battery. There were more significant differences in the exercises showing the changes in strength abilities of the participants in the experiment: Push-ups, Sit-ups, Long Jumps from Standing Position, and Hand Dynamometry in both researched groups. In our opinion, these positive dynamics in the increase in the strength indicators were due to the specifics and aim of the exercises executed in the experiment. The increased strength endurance in the upper body resulted from the exercises Burpee, kettlebell swings, dumbbell raise from a supine position, bench dips, and military press. The improvement in the explosive power of the lower limbs was a result of the complex influence of the exercises Burpee, Jumping Jacks, dynamic lunges, jump squats, and plyo box. The execution of stretching exercising during the cool-down improved the movability of the spinal column. The grip strength of the hands was positively influenced by the exercises Pull-ups, barbell rows, and dumbbell rows.

In both researched groups, there was a reliable higher level at the end of the experiment in the aerobic Beep test, which could be seen in the increase in the maximal running speed at failure. The improvements in the aerobic capacity resulted from the increased energy exchange due to the accelerated muscle metabolism and the reduction of body weight. Cohen's d is the appropriate effect size measure if two groups have similar standard deviations and are of the same size. It can be used to accompany reporting of *t*-test. The effect size of the measured indicators was large, as shows the coefficient of Cohen's *d*.

The united test battery we used is informative enough regarding the indicators of physical ability. The experimental training model developed by us is applicable in group and individual training ses-

sions at gyms.

We recommend that the experimental model be applied for a more extended period for more significant changes in physical ability and optimization of body structure.

Future research on this type of training load would make the results from its practical effect more precise.

CONCLUSION

The suggested experimental training methods are an easily accessed and efficient way to influence the muscles of the whole body and can be easily applied in all kinds of training conditions – with or without equipment and with great variation as regards the exercises used.

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REFERENCES

Comyns, T. (2018). *CIRCUIT TRAINING*. Development of Strength & Conditioning. Coaching Ireland.

EUROFIT. (1993). *Handbook for the EURO FIT tests of Physical Fitness*. Strasbourg: Council of Europe, I for the Development of Sport.

Fitzgerald, R. (2011). "The Metabolic Workout: Strip Off Excess Body Fat and Take Your Conditioning to the Next Level with Metabolic Circuit Training." *Joe Weider's Muscle & Fitness,* Vol. 72, no. 6, pp. 117–22.

Hirai, Y. & Tabata, I. (1996). Effect of high-intensity intermittent training and resistance training on the maximal oxygen deficit and VO2max, *Jpn J Phys Fit Sports Med*, Vol. 45, pp. 495–502.

Kenny, W., Wilmore, J., & Costill, D. (2012). *Physiology of sport and exercise*, 5th ed., Human Kinetics, Champaign

Klika, B. & Jordan, Ch. (2013). High-Intensity Circuit Training Using Body Weight: Maximum Results With Minimal Investment, *ACSM's Health & Fitness Journal*, Vol. 17, no. 3, pp. 8-13.

Kolimechkov, S., Petrov, L., Alexandrova, A., & Cholakov, K. (2018). BeepShuttle Junior: Software for the Administration of the 20m Shuttle Run Test in Children and Adolescents, *Journal of Advanced Sport Technology*, Vol. 1, no. 3, pp. 35-40.

Leger, A., Mercier, D., Gadoury, C. & Lambert, J. (1988). The multistage 20-meter shuttle run test for aerobic fitness, *J Sports Sci*, Vol. 6, pp. 93-101.

Miyamoto-Mikami, E., Tsuji, K., Horii, N., et al. (2018). Gene expression profile of muscle adaptation to high-intensity interval training in young men, *Scientific Reports*, 8:16811

Push-up test at home. Push-up test: Home fitness tests. (n.d.). Retrieved September 11, 2022, from https://www.topendsports.com/testing/tests/home-pushup.htm

Tabata, I. (2019). Tabata training: one of the most energetically effective high-intensity intermittent training methods, *The Journal of Physiological Sciences*, Vol. 69, pp. 559–572.

Tabata, I., Irisawa, K., Kouzaki, M., et al. (1997). Metabolic profile of high-intensity intermittent exercises, *Med Sci Sports Exerc*, Vol. 29, pp. 390– 395.

Tabata, I., Nishimura, K., Kouzaki, M., et al. (1996). Effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and VO-2max, *Medicine and Science in Sports and Exercise*, Vol. 28, no. 10, pp. 1327–1330

Viana, R., de Lira, C., Naves, J., Coswig, V., Del Vecchio, F., Gentil, P. (2019). Tabata protocol: a review of its application, variations and outcomes, *Clinical physiology and functional imaging*, Vol. 39, no. 1, pp. 1-8.

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EXPLORATION ON SALTO "JAEGER" PIKED TO HANG ON UNEVEN BARS

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ABSTRACT
The study of sports technique is of most importance for the improvement of elements in artistic gymnastics. Flight elements on uneven bars are a compositional requirement for any competitive apparatus combination. That is why the object of the study is one of the basic flight elements performed on the uneven bars – salto "Jaeger". It is performed on the backswing and consists of a front salto over the bar and regrip on the bar to hang. Jaeger salto is the most performed element in this structural group, and an analysis of the technique would reveal technical insights to optimize the sports technique. A comparative kinematic analysis of the performances of two gymnasts was made, who applied different technical solutions while moving the arms in the flying phase of the element. The software product SkillSpector Version 1.3.2 was applied for the analysis. The main joint units (toes, ankle, knee, pelvis, shoulder, elbow, wrist, fingers, chin, and forehead) are digitized. A mathematical model for computer simulations was applied to determine the effects of different arms movements. After the simulations, it was found that the applied two technical variants of arms movement also cause certain differences in the orientation and angular velocity of the body at the end of the flight phase. Recommendations have been made that can be useful for sports educators in practice to optimize the technique of the element.

Keywords: *Gymnastics, technique, uneven bars, "Jaeger".*

INTRODUCTION

Exercises with flight elements performed by men and women on the high bar and the uneven bars are among the most attractive and challenging ones in artistic gymnastics. These elements are an indispensable part of the routines of elite athletes because of their great difficulty and spectacular performance. To increase the technical level and effectiveness of the performances, researchers by tradition focus their scientific interest on studying various biomechanical characteristics and technical peculiarities of the elements. The scope of analyses includes elements such as: *Kolman and Pegan* (Čuk, 1995); *Gaylord* (McLaughlin et al., 1995); *Tkachev* (Holvoet et al., 2002; Čuk et al., 2009; Hiley et al., 2007; Naundorf et al., 2012, Hiley, Yeadon, 2012, Spencer, Schuhmann, 2017); *Gienger* (Potop et al., 2015); *Kovacs* (Hiley, Yeadon, 2016). The element *Jaeger salto*, whose performance technique is the object of analysis in the present research, is also very interesting. Heinen et al. (2011) present a computer simulation model on performances of extremely difficult elements on the horizontal bar – double *Jaeger* (tucked and piked). The study aims to analyze the mechanical conditions which could make this flight element possible for performance. The model was created using computer software and includes 16 hard segments. The segments are connected with 15 joint articulations. A 3D graphic model is presented to illustrate the results from the simulations (a sequence of images). Liu, and Zhou (2013) analyze the performance of the *Straddled Jaeger Salto* with a 1/2 turn to re-grasp. A kinematic motion model of this very hard element on the uneven bars is presented.

The present study aimed to establish the effect of arm movements on the rotation of the whole body during the flight phase in the performance of *Jaeger salto* on the uneven bars.

METHODS

Our attention is focused on two elements' performances which involve different arm movement techniques. The studied performances of *Jaeger salto* are recorded with a static video camera SONY with a frame rate of 25 pps, situated perpendicular to the gymnasts' lateral axis at the level of the rotation in compliance with all requirements of biomechanical analysis. The space is calibrated with 8 points, encompassing the performance perimeter with preliminarily known coordinates. The software product SkillSpector Version 1.3.2 is used for kinematic analysis, including a digitalizing model with 10 points (toes, ankle, knee, pelvis, shoulder, elbow, wrist, fingers, forehead, and chin).

A mathematical model for computer simulations is used to establish the effect of the body orientation (and angular velocity) as a result of the arm motion in the flight phase (Kyuchukov, 2021). The model includes 16 hard segments, and it is an angle-driven type of model. To achieve greater mobility, the

torso is divided into three parts. The relative movements between the 16 segments are provided by 15 joint connections, which ensure a very high level of mobility - 32 internal degrees of freedom. The external degrees of freedom are 6 (3 rotational and 3 translational). The basic segment in this model is the middle part of the torso, and for defining the orientation of the basic segment and the other body segments, modified angles of Euler are used, also known as x-y-z rotations or as Bryan angles. In the derivation of equations of motion, the conservation of angular momentum principle is applied. For the quantitative expression of the rotation movement, we use the term rotation potential, which is calculated as a product of the angular momentum and flight time, divided by 2π times the inertia moment when the body is straight (Hiley, Yeadon, 2008).

RESULTS

Using video observation we have registered two variants of technical motions with the arms in the unsupported phase of the *salto Jaeger* element on the uneven bars. The first one involves arm movements on the sides of the body– Figure 1 (a), and in the second, the arms move in front of the body – Figure 1 (b).

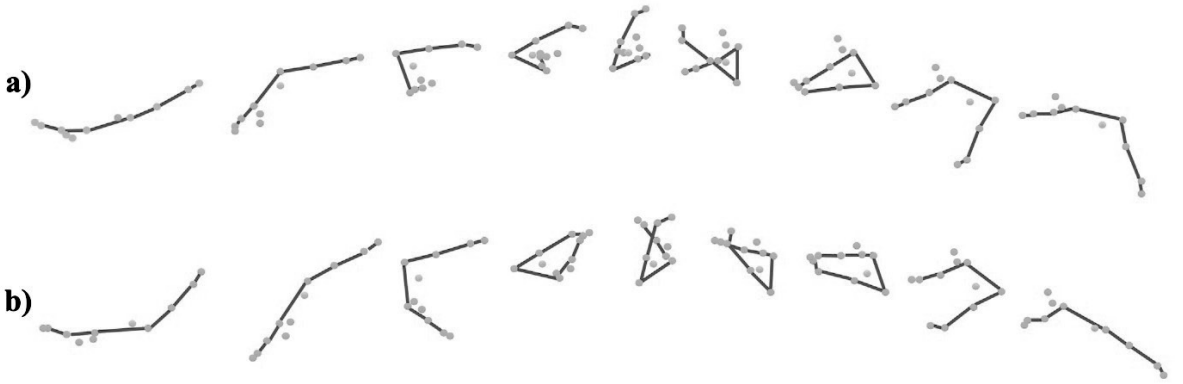

Figure 1. *A sequence of images with mechanical axes and the CG in the flight phase of the salto Jaeger on the uneven bars: a) – arm movements on the sides of the body; b) – arm movements in front of the body.*

In the first variant of the technique, the continuity of the unsupported phase is 0,8 sec. The gymnast is in an open body configuration at the moment of release of the bar. The angles formed at the shoulder and pelvis joints are 198° and 173°, respectively. After the release of the bar, there is an active flexion of the hip joint until the highest point of the CG is reached. At this moment, the gymnast's most flexed position in the hips (44°) and greatest *angular velocity* of the torso (11,89 rad/s) are observed. Together with the body flexion, the arms start moving down on the sides of the body. After reaching the highest point of the CG, the body extension begins with the arms lifted forward, which leads to a decrease of the *angular velocity*, facilitating the re-grasp of the bar. The body configuration is closed at the point of gripping the bar. The angle between the horizontal axis and the torso is 14°- Figure 2.

Figure 2. *Body configuration at the second grip of the bar after salto Jaeger version 1.*

In the second variant of the technique, the duration of the unsupported phase is 0,76 sec. The gymnast's body is in an open configuration at the moment of releasing the grip on the bar. The angles formed at the shoulder and hip joints are 179°and 221°, respectively. After the moment of releasing the grip of the bar, there is an active hip joint flexion to the highest point of the CG. The gymnast's most flexed position in the hips (36°) and greatest *angular velocity* of the torso (11,60 rad/s) are observed then. Together with the body flexion, the arms move down to forward position. After reaching the highest position of the CG, there is an extension of the hip joint, and the arm are held in the same position. The *angular velocity* of the torso decreases with the extension, and at the moment of gripping the bar, it is 0,6 rad/s. The gymnast's body is extended in the hip joints to 173° and flexed in the shoulder joints to 110°. The angle between the horizontal axis and the torso is 28°- Figure 3.

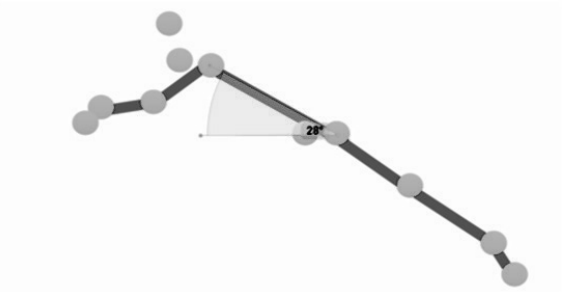

Figure 3. *Body configuration at the second grip of the bar after salto Jaeger version 2.*

We use the mathematical model to establish the effect of the arm movements on the body rotation. The results of the simulations are visualized and presented in Figure 4. First, we simulate the performance of the element in which the arms move on the sides of the body – Figure 4 (a). The necessary rotation potential for this performance is 0.491. In the second simulation – Figure 4 (b), the rotation potential is of the same value. Apart from the arms, the change of the other joint angles in the course of the movement is identical to the one from the first simulation. In the second simulation, the arms move in front. In the third simulation – Figure 4 (c), the change of all joint angles is identical, but the rotation potential is increased by 13.3 %, and it is 0.556.

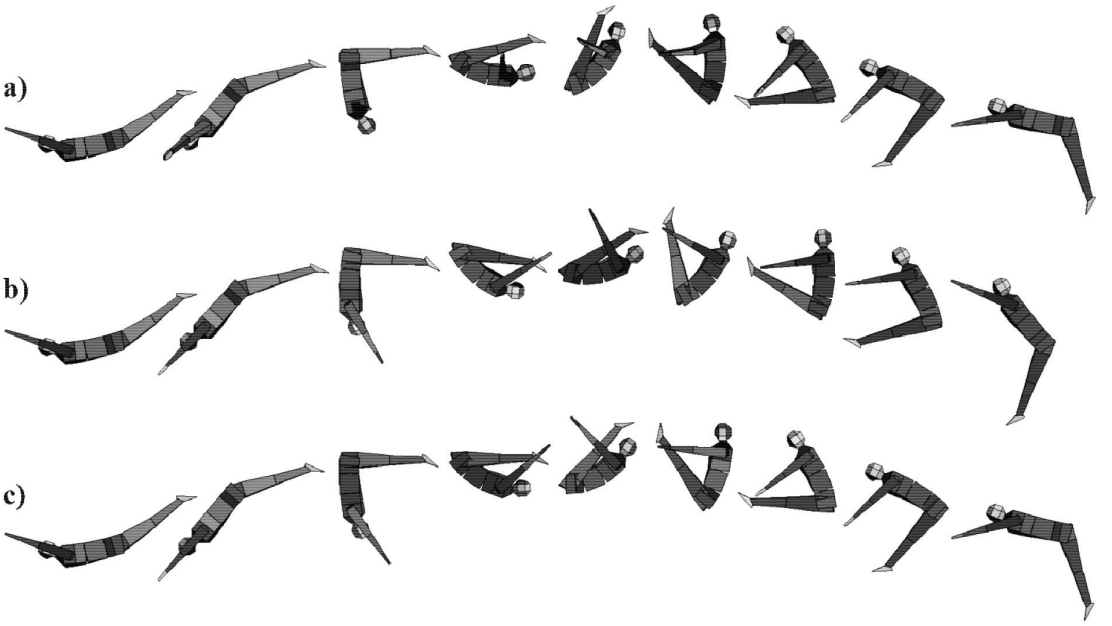

Figure 4. *A sequence of images (every 0.1 sec.) of the flight phase of Jaeger salto on the uneven bars: а) – the movement of the arms on the sides; б) – the movement of the arms in front; в) – the movement of the arms in front, at initial rotation potential bigger by 13.3 %.*

DISCUSSION

As we already stated, this study aimed to establish the impact of different arm movements in the flight phase of the performance of *Jaeger salto* on the uneven bars.

The kinematic analysis of the two registered variants of the technical movements of the arms in the unsupported phase of the element shows that the first variant with the arm movement on the sides of the body provides the gymnasts with better conditions for the re-grasp of the bar. The angle between the horizontal line and the torso of the gymnast at the end of the flight is 14° in variant 1 (Figure 2) and 28° (Figure 3) in variant 2, which presents a difference of 14° in the completion of the rotations before the grasp of the bar. The lateral movement of the arms helps for the greater *angular velocity* at the moment of the biggest flexion during the flight and for decreasing the *velocity* in preparation to finish the element - Figure 5.

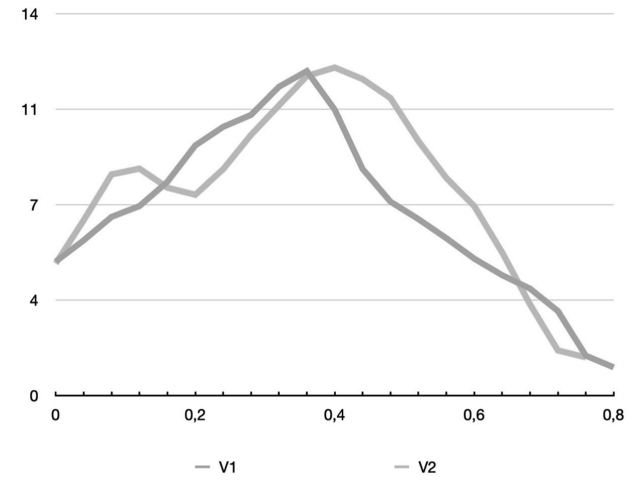

Figure 5. *Angular velocity (rad/s) of the torso in the flight phase of the Jaeger on the uneven bars.*

The simulations showed that with regards to the number of body rotations, the version with lateral arm movements – Figure 4 (a), is a little more effective. As we can see in the figure, applying the technique of arm movements in front of the body – Figure 4 (b), decreases to a certain extent the body rotation. At the end of the phase (Figure 4 b, the last image on the right), the torso is rotated 37° less than in the variant with the lateral arm movements. This result is somewhat expected since the movement of the arms in the front position causes a small counter-rotation of the remaining segments in a direction opposite to that of the body rotation. In order to achieve the same results as in the first variant, it is necessary to increase the initial rotation potential by 13.3 %. This implies slightly more intensive actions of the performer when still in contact with the apparatus (the bar).

CONCLUSION

After the completed kinematic analysis and numerical experiments, we could summarize that the variant of the *Jaeger* performance with lateral arm movement in the flight phase is more efficient with reference to the body rotation. Applying this technique causes slightly greater body rotation (by 37°**).** In the other considered variant – movement with the arms in front, a slightly larger initial rotation potential in the flight phase is required (in this case, around 13.3 %) for successful performance. Of course, certain nuances of arm movement (with different speed, arm flexion, movement in different planes) may cause a small difference with the quantitative data obtained during the experiment, but these differences will be insignificant and, in principle will not change the trends established in the study.

The presented quantitative information regarding the unsupported phase of this difficult and attractive element can serve as a guide and be useful to sport educators in their practical activities.

REFERENCES

Čuk, I. (1995). Kolman and Pegan saltos on the high bar. In T. Bauer (Ed.), *Proceedings-13 International Symposium on Biomechanics in Sports*, (119–122), Thunder

Bay, Ontario, Canada.

Čuk, I., Atiković, A. & Tabaković, M. (2009). Tkachev salto on high bar. *Science of Gymnastics Journal,* 1(1), 5-13.

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Heinen, T., Jeraj, D., Vinken, M. P., Knieps, K., Velentzas, K. & Richter H. (2011). What it takes to do the double Jaeger on the high bar? *Science of Gymnastics Journal*, 3(3), 7-18.

Hiley, M. J., Yeadon, M. R. & Buxton, E. (2007). Consistency of performance in the Tkatchev release and regrasp on high bar. *Sports Biomechanics*, 6(2), 121-130.

Hiley, M. J., Yeadon, M. R. (2008). Optimisation of high bar circling technique for consistent performance of a triple piked somersault dismount. *Journal of Biomechanics*, 41 (8), 1730–1735.

Hiley, M. J., Yeadon, M. R. (2012). Achieving consistent performance in a complex whole body movement: The Tkatchev on high bar. *Human Movement Science*, 31(4), 834-843.

Hiley, M. J., Yeadon, M. R. (2016). What governs successful performance of a complex whole body movement: the Kovacs release-regrasp on horizontal bar? *Journal of Biomechanics*, 49(16), 3971–3976.

Holvoet, P., Lacouture, P. & Duboy, J. (2002). Practical use of airborne simulation in a release-regrasp skill on the high bar. *Journal of Applied Biomechanics,* 18, 332-344.

Kyuchukov, I. (2021). *Biomechanical models of non-support phase of gymnastics elements with combinations of rotations.* D.Sc. Dissertation, Sofia, National Sports Academy "V. Levski".

Liu, Yi & Jihe Zhou, J. (2013). Kinematic analysis of Li Ya salto connecting straddled Jaeger salto on the uneven bars. *31 International Conference on Biomechanics in Sports* (2013), Taipei, Taiwan, C3-5 ID164.

McLaughlin, P.A., Geiblinger, H. & Morrison, W.E. (1995). Kinematic analysis of the Gaylord I on uneven bars performed by Mo Huilan (China). In T. Bauer (Ed.), *Proceedings-13 International Symposium on Biomechanics in Sports (1995),* Thunder Bay, Ontario, Canada.

Naundorf, F., Brehmer, S., Lehmann, T. & Seidel, I. (2012). On the way from straddled to stretched Tkatchev on high bar. *30th Annual Conference of Biomechanics in Sports* – Melbourne 2012, 132-135.

Potop, V., Grigore, V. & Timnea, O. C. (2015). Biomechanical characteristics of key elements of Gienger salto technique on uneven bars. *Procedia - Social and Behavioral Sciences* 191, 372 – 377.

Spencer, K. & Schuhmann, M. (2017). The influence of body position on the straddled Tkatchev's flight phase in men's horizontal bar. *Journal of Human Sport and Exercise,* 12(1), 204-218.

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HEART RATE AND BLOOD LACTATE MONITORING DURING MICROCYCLE AND MESOCYCLE IN ACROBATICS GYMNASTICS

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ABSTRACT
Periodization and planning of the training load is an essential process in the preparation of an elite gymnast. On the one hand, the coaches and gymnasts have to achieve the necessary level (individual maximum) of the volume (quantity of elements and routines), and on the other hand, they have to do it at the "right time". Last but not least is to prevent the gymnasts from injuries. That is why we need to study the dynamic of the training load from a physiological point of view and should have a better understanding of how the body's system responds.
This study aims to observe body reactions to the training load during one microcycle and one mesocycle in acrobatics gymnastics. One female youth Olympic champion (18 years old) and one male bronze medallist from junior WCH (26 years old) were tested. The study was made at the end of the preparation period and the beginning of the competitive period. The indicators measured were HR, blood La. Heart rate was recorded by Suunto Ambit 2. A drop of blood sample was taken from the fingertip to assess the average peak blood lactate concentration using an Accutrend Plus Roche. A heart rate record was made during one week of training (6 training days). Monitoring of the blood La took place once a week (every Thursday) for one month. The obtained results show how the gymnast body's systems react to the training load in microcycles and mesocycle in acrobatics gymnastics. The data allow timely optimization of the training load and is a prerequisite for the improvement of the next periodization and planning of the training load not only for gymnasts that were tested but also for high-level gymnasts (Mixed Pair) with similar age and anthropometric indicators.

Keywords: *gymnastics, acrobatics, training load, heart rate, blood lactate*

INTRODUCTION

Periodization and planning of the training load is an essential process in the preparation of an elite gymnast. On the one hand, the coaches and gymnasts have to achieve the necessary level (individual maximum) of the volume (quantity of elements and routines), and on the other hand, they have to do it at the "right time". Last but not least is to prevent the gymnasts from injuries. That is why we need to study the dynamic of the training load from a physiological point of view and should have a better understanding of how the body's system responds.

This study aims to observe body reactions to the training load during one microcycle and one mesocycle in acrobatics gymnastics.

METHODS

One female youth Olympic champion (18 years old) and one male bronze medallist from junior WCH (26 years old) were tested. Both are part of the Bulgarian National team, and their best result was 6th place in the European Championship in 2019. The study protocol was reviewed and approved by the Ethical Committee of the National Sports Academy. It was conducted in agreement with the principles stated in the Declaration of Helsinki for human studies. The study was made at the end of the preparation period and the beginning of the competitive period (mesocycle – 4 weeks). The indicators measured were the heart rate and the blood lactate concentration. Heart rate was recorded by Suunto Ambit 2. A drop of blood sample was taken from the fingertip to assess the average peak of the blood lactate concentration using an AccutrendPlus Roche (once a week – Thursday). A complete record of the heart rate was made for a week (6 training days/10 training sessions). HR was recorded only once a week (with the blood lactate) for the other three weeks of the tested period.

RESULTS AND DISCUSSION

Before analyzing the physiological indicators, the training load's volume and intensity need to be known. The number of elements, routines, parts of the routines, and difficulty of the exercises is shown in the tables below. Consideration of the anthropometric indicators of the acro gymnasts has to be made. The gymnasts' personal weight and height significantly impact the sport result and their differences (Ivanov, 2021). The person-

al weight and height of the top are 52 kg and 168 sm. The personal weight and height of the base are 84 kg and 182 cm. From a biomechanical point of view, the Top has no typical body size but larger than usual. All kinematics and Dynamic parameters of the movement will increase, which means all aspects of the technique must be performed very precisely. Otherwise, any slight inaccuracy in the technique will lead to a massive mistake (fall from the element) or will cost "too much" energy, which will reflect on the following elements. The anthropometry of the Top "will cost" much more energy for the Pair. With the Top growing up, the exercises from previous years are impossible. However, regarding the HR and the blood lactate, we must know that the gymnasts need a "full recovery" before the following routine or a few elements in one go.

In Figures 1, 2 & 3, we can see the performed elements in each of the three routines as follow:

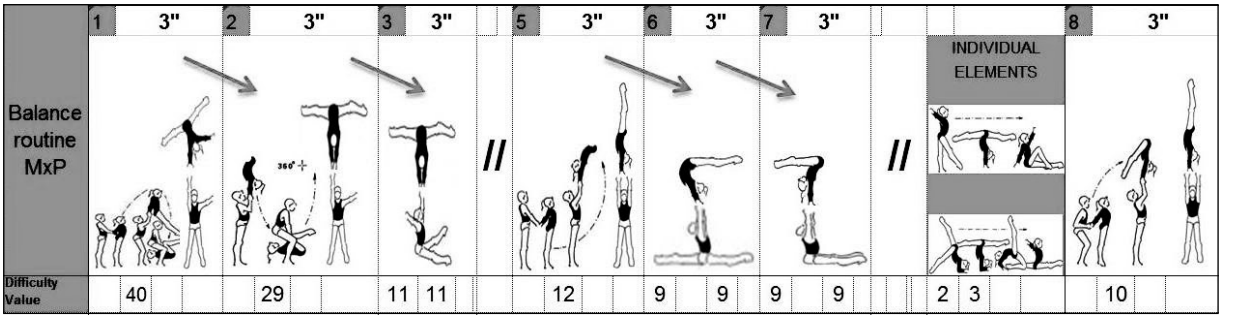

Figure 1. *"Balance routine elements"*

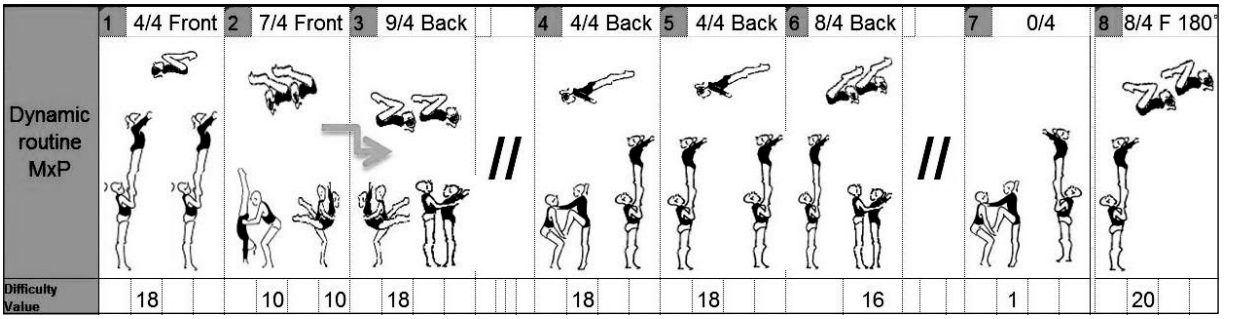

Figure 2. *"Dynamic routine elements"*

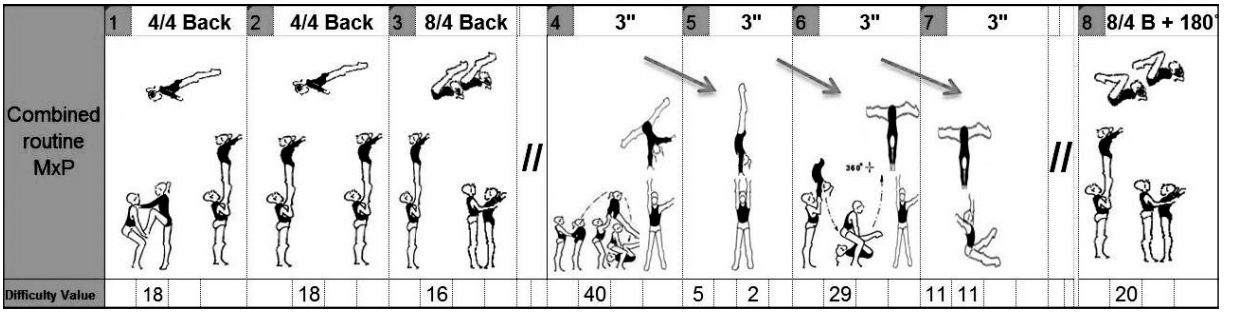

Figure 3. *Combined routine elements*

On the one hand, the difficulties of the elements of the routines, together with anthropometric parameters, will show the whole "picture" of the effort (load) that this Pair does. On the other hand, it proves the gymnasts' technical level and validates this case study's results. The Difficulty Score is in the top 8 in the last two European Championships – Holon 2019; Pesaro 2021 (Ivanov, 2021).

Table 1. *Volume and Intensity during the microcycle*

29.03.21 - 03.04.21	Monday	Tuesday		Thursday	Friday	Saturday	Total
Training Session	2	2	1	2	2	1	**10**
Total time (min.)	200	310	140	202	200	134	**1186**
Warm-up (min.)	46	48	25	50	54	21	**244**
Choreography (min.)	-	-	15	10	10	20	**55**
Specific physical preparation	5	7	3	5	3	8	**31**
Preparation Elements	15	10	5	15	12	20	**77**
Elements	30	20	18	23	20	17	**128**
2/3 link Elements together	4	3	5	6	7	10	**35**
Part of routines	2	1	7	2	2	-	14
Routines	4	6	3	5	7	1	**26**
Heart Rate Max							
T.V. (M)	181	186	185	187	182	192	X - 185.5
M.K. (F)	179	192	206	191	187	178	X - 188.8

However, the results (Table 1) of the training load and intensity in one microcycle (one week) are at the beginning of the competitive period (from 29.03.2021 to 03.04.2021 – the last week of the monitoring). One month before the first competition of the season, there are two or three microcycles with a peak of the training load. The presented results (Table 1) are a good starting point to analyze the training load and the obtained values – HR and La. The gymnasts reach submaximal HR values – T.V. (Male – The Base) – 96% and M.K. (Female – The Top) – 93% from their theoretical maximum. These results also confirm our previous studies (Ivanov, 2018). More analysis and results of the heart rate dynamic during the training sessions and during the routines need to be done.

For example (Figure 4), we will track the Heart Rate of the top (F – M.K.) during one training session. We have an individual warm-up in the first 20 min of the training, followed by 5 min conditioning and 10 min individual or group preparation for the main part of the training. The main part of the training consists – of 10-min elements; 10 min. for small parts (3 elements in one go). With this, the preparation for the first routine is done in less than an hour. The training session registered three top peaks of the HR, which are at the end of the three routines done for the day. Between the routines, there are smaller peaks of the HR which are some combinations (a small part of the routine – 3 to 4 elements in one go) in preparation for the next routine. After completing the routines, the heart rate dynamic shows the cardiovascular reaction from the specific physical preparation. More or less, the specific physical preparation looks like the same elements from the routines but is performed in a more challenging way (for example, one arm straights hand to hand hold for 10-15 sec.) In comparison – in the "Code of Points," the special requirements are a 3-sec hold. Another example – walking off the Base during the transitions of the top – Straddle to Handstand (power), etc. The last part of the training session is stretching for 6-7 min. The order of the routines during the training sessions is always the same. They start with Balance, then Combine, and after that is a Dynamic routine.

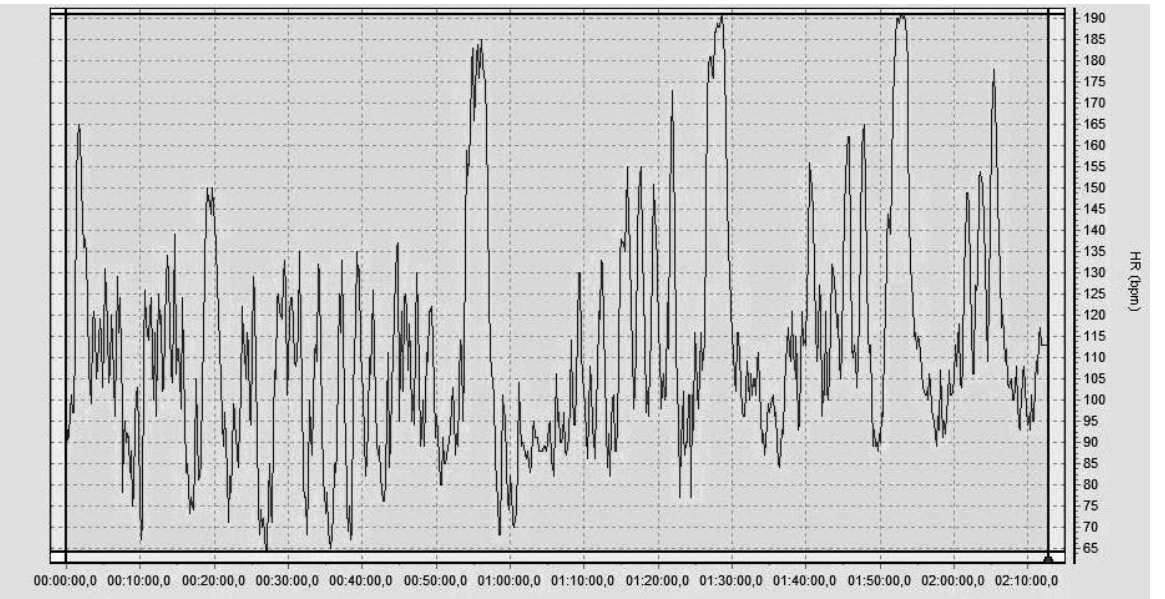

Figure 4. *Dynamic of HR during the training session.*

Figure 5 shows the dynamics of the combined routine. The Top gymnast starts the routine with an HR of 111/bpm and reaches above 180/bpm for less than 20 sec. (after the first three dynamic elements). Next 20 seconds of the routine, the HR goes up to 176/bpm (during the choreography), and there is another peak of 189/bpm (during the balance elements). After the balance elements (choreography), again, the values go down and reach a "steady state" of 187/bpm. The last peak (in the previous two dynamic elements) reaches 191/bpm. Only 10% of the duration of the routine is under 160/bpm. The rest of the routine is above this zone, respectively around 20% is in the zone of 160-180/bpm, and the rest of the routine (70%) is above 180/bpm. Compared to previous studies, there are some differences (Ivanov, 2018, 2020), where 70% of the HR is in zone 160-180/bpm. However, we can say that the different results have a few reasons. First of all, is the target group – both cases are with high-level gymnasts but of different ages (male – average 15,6 (±1,4); female– average 15,5 (±1,8)). The second reason is moving from Junior to Senior; there is a massive increase in the difficulty (younger gymnast competed at a junior level and is first-year senior in the present study). That means they have a huge difference in the difficulty values and anthropometrical indicators (including the difference between partners).

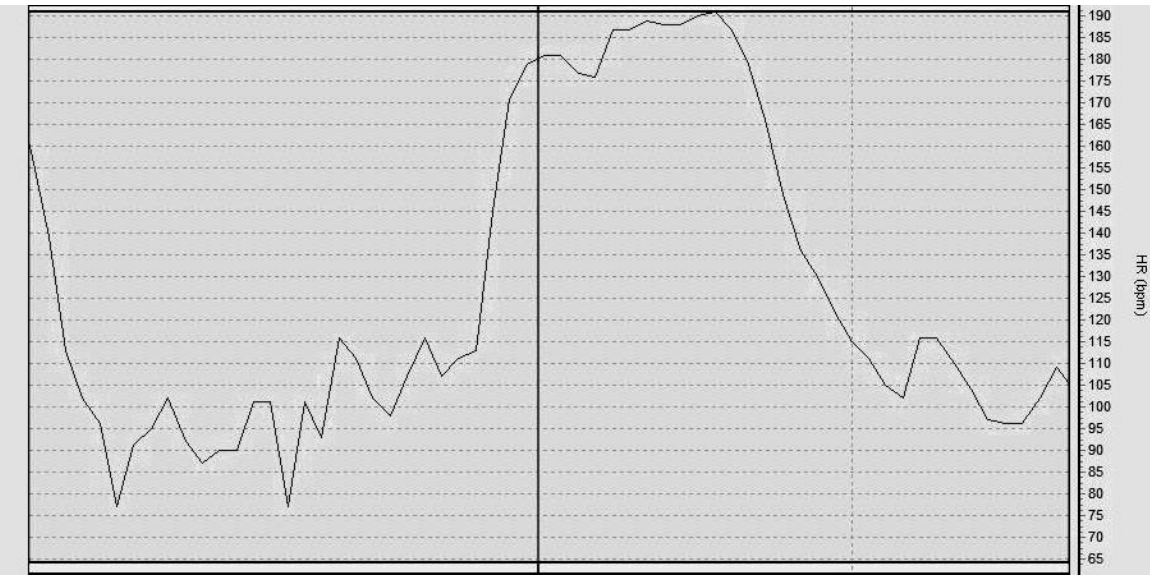

Figure 5. *Dynamic of HR during the combined routine.*

The result of the heart rate during the mesocycle is presented in Table 2. There is a sign of improving the adaptation mechanisms of the gymnasts, except for the last week from the mesocycle. The result from blood Lactate (Table 2) confirmed the values of HR. However, the reason for the high-level values of HR and La of last week of the mesocycle was the presence of many technical mistakes during the elements and the routines, which led to more significant effort from the gymnasts' site.

Table 2. *Dynamic of HR during the mesocycle*

Sofia	Parameters	Start of training	HR Max During warm-up	Before 1st routine	1st routine (HR Max)	2nd routine (HR Max)	3rd routine (HR Max)
11.3.2021							
T.V. (M)	HR	95	136	115	187	190	Not performed
M.K. (F)	HR	72	147	143	195	192	Not performed
18.3.2021							
T.V. (M)	HR	79	165	108	179	180	186
M.K. (F)	HR	70	148	97	180	184	184
25.3.2021							
T.V. (M)	HR	88	143	109	174	176	179
M.K. (F)	HR	88	162	89	180	182	186
1.4.2021							
T.V. (M)	HR	85	135	116	182	186	187
M.K. (F)	HR	88	161	95	185	191	191

At the beginning of the mesocycle, the gymnast reaches the highest values of blood lactate.

Table 3. *Dynamic of Lactate during the mesocycle*

Sofia	Parameters	Start of training	After warm-up	Before 1st routine	After 1st routine	After 2nd routine	After the last routine
11.3.2021							
T.V. (M)	La	2.7	5.2	2.4	17.1	16.8	Not performed
M.K. (F)	La	3.4	6.4	5.2	18.4	17	Not performed
18.3.2021							
T.V. (M)	La	1.4	4.3	2.6	6.9	9.4	7.5
M.K. (F)	La	2.2	3.6	7.5	5.7	5.6	5.1
25.3.2021							
T.V. (M)	La	2.1	6.6	3.5	9.6	9.4	7.7
M.K. (F)	La	1.9	5.9	2.5	4.5	6.1	4.4
1.4.2021							
T.V. (M)	La	1.2	6.8	6.6	9.1	9.7	7
M.K. (F)	La	3.4	3.8	2.2	6.2	6.4	4.1

CONCLUSIONS

Anthropometric indicators significantly impact performance from a physiological point of view.

The load of Seniors level in acrobatics gymnastics routine with similar difficulty and anthropometrical indicators is over the submaximal zone of work.

The present study creates the overall view of the training load in one microcycle and mesocycle in acrobatics gymnastics.

The data from this research will be the starting point for new studies in the direction of "how much" the technical level (motor habit) and anthropometrical

indicators reflect the body's systems of high-level acro gymnasts.

REFERENCES

Andonov, K., Gateva, M., Ivanov, N., Mateev, G., Srefanova, D., Tarnichkova, M., Tzvetkov, S. (2014). "VO-2max of high-level athletes in the gymnastics disciplines", *conference "Sport, Stress, Adaptation",* Sofia, p.28.

Douda, H., Toubekis, A., Avloniti, A., Tokmakidis, S. (2008). Physiological and Anthropometric Determinants of Rhythmic Gymnastics Performance. *International Journal of Sports Physiology and Performance,* HumanKinetics, Inc. Vol. 3, pp. 41-54.

Gateva, M. (2019). Modified field test for determining the specific endurance in rhythmic gymnastics. *Journal Of Applied Sport Sciences*, Vol.1, pp.3-12.

Gateva, M., Tarnichkova, M., Ivanov, N., Andonov, K. (2014). Comparison of the 2 min modified laboratory test applied in the gymnastics disciplines during the preparatory period—*19th Annual Congress of the European College of Sport Science,* Amsterdam, p.209.

Ivanov, N., Gateva, M., Tarnichkova, M. (2014). Unified methodology for applying laboratory and field tests for different gymnastics disciplines. *XVI Scientific Conference "Fis communications",* pp.50-54.

Ivanov, N. (2018). Investigation of load in balance acrobatics gymnastics routine, *Journal of "Sport and Science"*, LXII, N-1, pp. 44-53.

Ivanov, N. (2018). Comparative analysis of load between balance and dynamic acrobatics gymnastics routines". *Journal of "Sport and Science",* Vol. 5, pp. 3-11.

Ivanov, N. (2020). Comparison of the load between standard and modified acrobatics gymnastics routines. *Annual of NSA "Vassil Levski",* NSA Press, pp. 119-130.

Ivanov, N. (2021). Investigation of the influence of the anthropometric characteristics on results in acrobatic gymnastics, NSA, IPB, pp. 185-195.

"Code of points - 2017 – 2020". (2017). Acrobatics gymnastics, F.I.G.

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AN INVESTIGATION OF LOWER EXTREMITY CONTROL OF ADOLESCENT FOOTBALL PLAYERS

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ABSTRACT

The aim of the present experiment is to make a combined kinematics and dynamic analysis of test movements in adolescent football players and to perform an assessment of the muscle control of the lower limbs. 22 adolescent (12-years old) football players have been researched by means of a complex method for simultaneous registration of dynamometric and kinematic parameters of motor control. Two video cameras and a tens platform were used. The researched persons have been performing two test movements landing on the tens-platform from a standardized height of 35 centimeters and a jump and landing on the tens-platform. The analysis was effectuated by joining a software program for kinematic analysis "KINOVEA" and the dynamometric one by a specialized computer dynamometric system by a measuring platform. At the moment of maximum exertion, the angle between the thigh and the shank was measured. The distance between the knees at the moment of amortization was shot by means of the video camera placed in front. The juxtaposition of the change of the distances between the knee joints with the initial values shows a medialization in all researched persons. This is an indication of a deficit in the muscle control of the lower limbs. The coefficient of variation and the range demonstrate the presence of significant differences in the distance between the knee joints in different persons. The values in both tests prove to be rather close landing from a standardized height and a jump from a platform. In the angle of flexion at the moment of the maximum foothold reaction upon landing from a standardized height there are no big differences in the studied persons. In the jump from a platform the maximum values of the flexion are greater and the range of the values as well. This indicated to a greater individual dependency of the amortization phase of the landing on the very jump.

Keywords: *knee, valgus, landing, kinematic, analysis.*

INTRODUCTION

Lots of authors pay attention to the muscle strength, muscle control, and muscle balance as factors influencing the frequency of traumatism in football. The stabilization of the body segments is a result of the mutual interaction between bone geometry, capsule - ligamentary structure and muscles. Moreover, it is well-known that muscles are the active structures in this complex. The contraction of the myofibers counteracts actively against the potentially dangerous forces arising in movement. In that way, it protects the passive structures – bone and joint elements of the body framework (skeletal) supporting the motor apparatus from structural injuries. In that way strength as a major functional quality of the muscle appears to be definitive in the achievement of dynamic stabilization. If the stabilizing influence of muscles is compromised, the risk of traumatic injury of the capsule-ligamentary apparatus and the bones increases. (Moore, Wade, 1989; Bonci, 1999).

The impaired muscle control of the lower limb is visualized by an augmented medial translation of the knee in the realization of various maneuvers of sports activity (Andrews, 1985).

This results in an increased valgus moment in the knee joint, which produces a stress not only in it but also in the entire lower limb (Hewett, 1996; Ford, 2003; Myer, 2003). Many authors prove a neuro-muscular disbalance in women by measuring the valgus in the knee-joint or by the distance between the knee-joint in a coronary plan, comparing the results with such one in men (Chapell, 2002; Hewett, 2004).

As a generalization and proof of these theories, Hewett et al. prove that the precise biomechanical analysis of the neuro-muscle control and the valgus exertion of the knee joint can predict the damages to the anterior cruciate ligament of the knee. (Hewett et al.,2004).

Aim and objectives

The aim of the present experiment is to make combined kinematics and dynamic analysis of test movements in adolescent – 12 years old football players and to perform an assessment of the muscle control of the lower limbs.

METHODS

22 - adolescent – 12 years old football players have been investigated by means of a complex method for simultaneous registration of dynamometric and kinetics parameters of motor activity.

The parent's consent was taken. The procedure was in the following steps:

- explanation to the parents about research methods – aim and importance of injury prevention;

- explanation to the parents and children about the essence of exercises;
- the exercises were demonstrated to the parents and children;
- every child was in good health condition;
- all parents were present at the moment of their children's performance (the procedure was at the end of Saturday's training session);
- the research was held under medical control;
- the procedure considered all Conventions of Children's rights;

Two video cameras and a tens-platform were used. The two cameras are situated under a right angle and are with a speed of shooting – 30 stills per second with a chance for a through – row decoil up to 60 stills per second. The investigated persons have been performing two test movements landing on the tens platform from a standardized height of 35 centimeters and a jump and landing on the tens platform (Figure1).

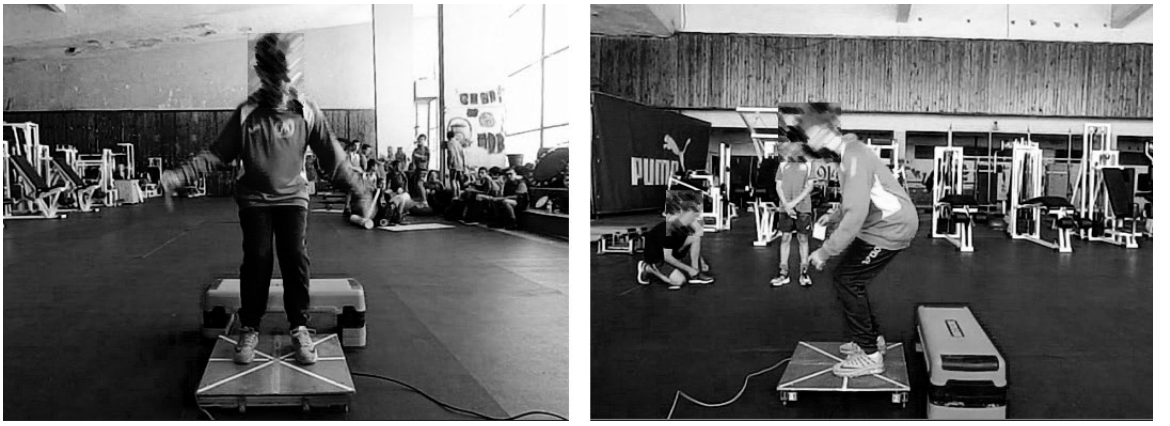

Figure 1. *Landing on the tens-platform from a standardized height*

The analysis was effectuated by joining a software program for kinematic analysis "KINOVEA" and the dynamometric one by a specialized computer dynamometric system by a measuring platform.

At the moment of maximum exertion, the angle between the thigh and the shank has been measured by shooting with a distantly placed video camera. The distance between the knees (valgus moment – Figure 2) and range of knee flexion (Figure 3) at the moment of amortization were shot by means of the video camera placed in front.

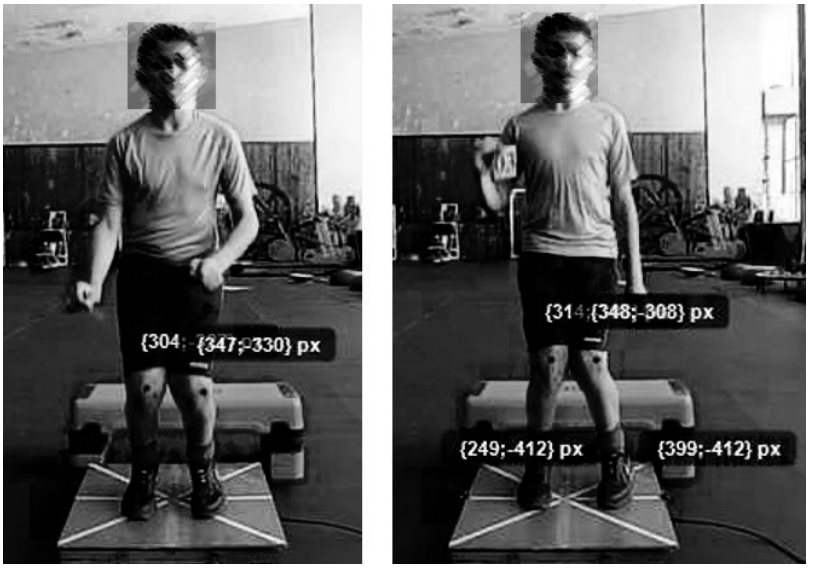

Figure 2. *Knees valgus moment*

Figure 3. *Range of knees – flexion*

RESULTS

The presented data contains a variation analysis of the jumps made from the stand and dynamometric platform. The maximum efforts in the jump from the stand and jump from the platform in kilograms have been estimated. For the purpose of the exact calculation the weight of the athletes has been accomplished by the help of an anatomic scale in kilos. The measured experimental data show a normal distribution according to the low values of the coefficient of variation V, coefficient of asymmetry As and the coefficient of excess Ex. The maximum and the minimum values of the quantities in the studied sample are designated with Max and Min (Figure 5) and average values are shown in the Figure 4. The algebraic difference R (span) is shown in the Figure 5.

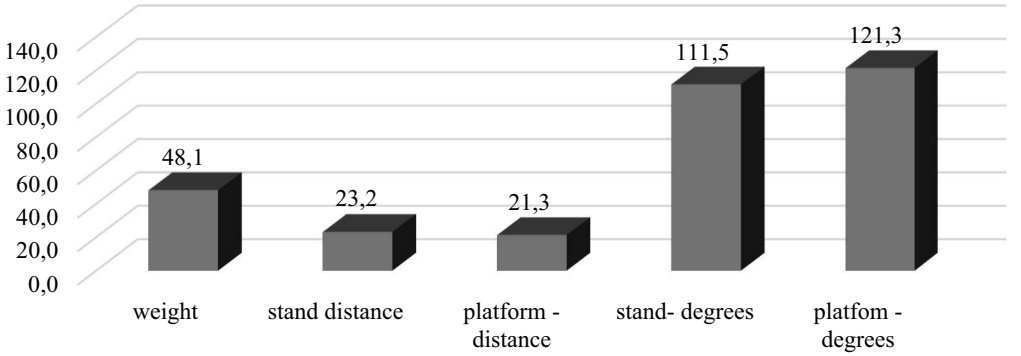

Figure 4. *Average values (max. ground reaction force)*

The juxtaposition of the change of the distances between the knee joints with the initial values shows a medialization in all investigated persons. This is an indication of a deficit in the muscle control of the lower limbs.

The coefficient of variation and the range demonstrate the presence of significant differences in the distance between the knee joints in the different sportsmen. The values in both tests prove to be rather close landing from a standardized height and a jump from a platform. In the angle of flexion (bending) at the moment of the maximum foothold reaction upon landing from a standardized height there are no big differences in the studied persons. In the jump from a platform the maximum values of the flexion are greater and the range of the values as well. This indicated to a greater individual dependency of the amortization phase of the landing on the very jump.

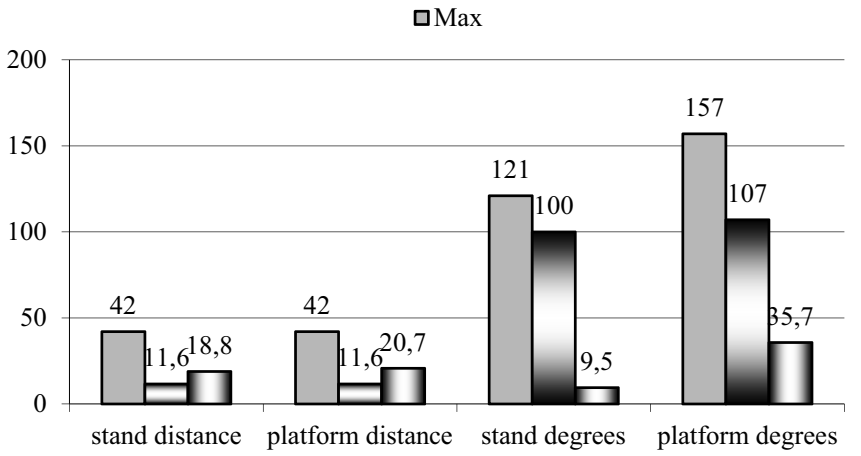

Figure 5. *The maximum and the minimum values of the quantities in the studied sample*

CONCLUSION

The approved complex method renders an opportunity for a joint (combined) kinematic and dynamometric analysis of the muscle control of the lower limbs. The data thus obtained create a platform for further such investigations in adolescent football players (up to now being lacking in Bulgaria).

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Special acknowledgments to all coaches of PFC "Levski "– Sofia - "Youth football school" for their collaboration.

REFERENCES

Andrews, J., Axe, M. (1985). The classification of knee ligament instability, *Orthop Clin North Am.* Vol 16 pp. 69-82,

Andrish, J.T. (2001). Anterior cruciate ligament injuries in the skeletally immature patient, *Am J Orthop*.; Vol.30, pp 103 - 110

Arendt, E. & Dick, R. (1995). Knee injuries patterns among men and women collegiate basketball and soccer players. NCCA data and review of literature. *Am. J. Sports Medicine*, Vol.23, pp 694-701

Bonci, Chr. (1999). "Assessment and evaluation of predisposing factors to anterior cruciate ligament injury", *J Athl Training*. Vol.34, pp 155-164

Chappell, J., Yu, B., Kirkendal, D. & Garret, W. (2002). A comparison of kinetics between male and female recreational athletes in stop-jump tasks, *Am J Spotrs Med*. Vol 30, pp 261-267,

Ford, K., Myer, G.& Hewett, T. (2003). Valgus knee motion during landing in high school female and male basketball players. *Med Sci Sports Exerc*., Vol 35, pp. 1745-1750

Hewett, T., Myer, G. & Ford, K. (2001). Prevention of anterior cruciate ligament injuries, *Curr Women's Health Rep*., Vol.1, pp 218-224,

Hewett, T., Myer, G., Ford, K.et al. (2004). Biomechanical: erasures of Neuromuscular control and valgus loading of the knee predict ACL injury risk in female athletes", *Am J Sports Med*, Vol33, No 4, pp:492-501

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AN EXPLORATIVE STUDY OF THE DEPENDABILITY OF THE EXECUTION ON ROUTINE SCORING GOAL IN FIELD HOCKEY

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ABSTRACT
Biomechanical analyzes of field hockey players have been developed. The analysis was made for shooting in the door by video recording from two high-speed video cameras. For each of the blows with the stick, kinematic analyzes were made both from a point of view in a direction perpendicular to the plane of the blow on the ball, and from a rear point of view relative to the athlete.
The aim of the development is to establish significant statistical regularities accompanying the repeatability of the stability of the motor habit in the effective execution of the blows on the ball in the hockey goal.
Methods
The scale of the shooting covers the athlete in general shooting. 8 control markers placed on the front of the stick, the right wrist, the right elbow, the right shoulder, the right and left knees, the right and left feet were used in the video recording from the lateral point of view. The same model for marking control markers is used when shooting the athlete from a rear view. The criterion for the selection of the studied points is to be visible when shooting. Additional lighting is used to increase the contrast required for automated kinematic analysis.
Results and analysis
Statistical analyzes of the shocks during the shooting were made, including the limit values of the linear velocities of the examined points by the athlete's body during the execution of the shot in the door. The statistical processing includes variation, correlation, regression and anatomical analyses establishing the stability of the motor habit when performing the stroke by different athletes from the national hockey team.
Statistically significant correlation and regression models were established connecting the instantaneous velocity of the blow with the stick on the hockey ball and the instantaneous values of the examined points of the athlete's body.

Keywords*: shooting, videometric, kinematic, anatomical, analysis.*

INTRODUCTION

The aim of the cited study according to Eskiyecek1 G. et. al, 2019 is to compare target and non-target techniques ((primarily corner characteristics) for drag, flick field hockey in the penalty corner area, as used 3D kinematic analysis of 11 players using seven high-speed cameras (Oqus 7+) at 120Hz per second.

In the cited paper by Ibrahim R., et al, 2017 achieving high stick head and therefore ball speed is essential for successful drag flick execution in field hockey, but the coordination pattern used to maximize clubhead speed is unknown. The kinematics of the drag flick were studied in ten elite ice hockey players who performed twenty shots each at a target placed at a height of 1.5 m. A 150 Hz active marker motion analysis system was used along with two dynamometric platforms for foot touch detection. The angular velocity and its contribution to the terminal velocity of the stick are analyzed.

According to Swarén et al, 2019, this study investigates the possibility of using a passive motion capture system for the 3D kinematics of two hockey players. Kinematic data were collected from 20 cameras at a frequency of 300 Hz, a resolution of 12 megapixels and an average deviation for all cameras of 3.4±2.5 mm, at a distance of 11.6 m.

According to Meulman et al, 2011 the drag flick technique in field hockey is an important scoring "weapon".

As a conclusion from the displayed publications related to videometric analysis of field hockey, the method of video recording with high-speed video cameras and registering the movement of selected control markers on points of the athlete's body prevails. On the other hand, according to Meulman et al, 2011 the importance of the problem under consideration and high. The proposed hypothesis of the study assumes that there is a strong correlation dependence for the kinematic characteristics at the time of hitting the ball for characteristic points of the player's body, which is higher for athletes with

advanced motor habit.

Aim and objectives

The aim of the research is to evaluate the stability of the athlete's motor activity during repeated shots at the goal by evaluating the linear velocity of characteristic points of the athlete's body. To solve the goal, the following tasks have been formulated:

1. Implementation of video recording and kinematic analysis of the motor activity of the players when shooting at the goal.
2. Determination of the coordinates of the points of the stick's trajectory and the selected control markers at the moment of impact.
3. Variational analysis of the players' shooting experience data.
4. Correlation and regression analysis of the results of the attempts made by the players.
5. Anatomical and biomechanical analysis.

METHODS

The contingent of our study is a total of 6 junior field hockey players selected in the extended composition of the national field Hockey5 team of Bulgaria, U 16 (Average age on the day of testing - 15.4 ± 1). For all participants, signed informed consent is received from their parents for the testing and for the publication of the results.

Methodology

The research methodology includes a videometric analysis of the athlete's motor activity in general by registering the coordinates of pre-selected 8 control markers-points placed on the player and indicated by a contrasting white tape. Two high-speed video cameras are placed perpendicular to each other, one recording the movements in the direction opposite the door, and the other in the direction perpendicular to it. The criterion for the selection of the studied points is that they should be visible during shooting. In order to achieve sufficient contrast, additional halogen or other lighting is installed - minimum 500 watts.

Both video cameras are set to a frame rate of 120 frames per second. The speed shutter (speed shutter) of video cameras is set to 1 / 2000 per second, which improves the detail of the frame during fast movement. The selected capture points on the players are as follows:

1. The point of contact on the ball at the moment of impact with the stick.
2. The wrist of the clubbing hand
3. The eponymous elbow of the same hand.
4. The shoulder of the same name.
5. The knee of the lower limb of the same name.
6. The foot of the limb of the same name.
7. The knee of the other limb.
8. The foot of the other limb.

The video cameras are placed on tripods at the same height so that the player's movements are in a general plan and at the same distance from the area of future motor actions. At the operator's signal, the video cameras are switched on and then the player starts consecutively shooting the ball into the goal until all the intended attempts are completed. A computer monitor is placed in the shooting field, on which the player's sequence number visible from the video cameras is indicated. After the shooting is finished, the video recording is stopped and preparation for the next athlete follows.

The videos are edited and numbered for consecutive shooting attempts, removing excess material. Kinematic analysis was performed with the open access computer program Scilspector (2018). The total number of kinematic analyzes is 30 for one player or 180 for all participating athletes. Only the values of the linear velocities at the moment of impact on the ball are selected from the individual kinematic analysis since the contact with the stick determines the free flight of the ball when shooting.

Calibration of the field of view is performed by photographing laths of pre-selected dimensions, the values of which are entered into the Scilspector computer program. The kinematic analysis is performed for both mutually perpendicular directions. The data is recorded in an Excel spreadsheet and summed using the Pythagorean formula to arrive at the final result.

RESULTS

Table 1. *Average values at the moment of impact (player #1)*

player #1	Stick [m/s]	wrist [m/s]	elbow m/s]	shoulder [m/s]	Right knee [m/s]	Right foot [m/s]	Left knee m/s]	Left foot [m/s]
X	19.7	7.3	4.7	3.0	2.1	2.4	0.9	0.6

Table 2. *Correlation Chart (Player #1)*

player #1	stick							
wrist	.895**	wrist						
elbow	.795**	.858**	elbow					
shoulder	.877**	.925**	.855**	shoulder				
Right knee	.752**	.687**	.663**	.778**	Right knee			
Right foot	.528*	.462*	.320	.398	.507*	Right foot		
Left knee	.598**	.765**	.687**	.626**	.417	.191	Left knee	
Left foot	.516*	.720**	.720**	.681**	.437	.254	.686**	Left foot

Regression equation (Player #1)

$$V\ ball = 4{,}03+1{,}65*V\ wrist + 2{,}18*V\ right\ knee - 1{,}37*V\ left\ foot \quad (1)$$

In our opinion, at the moment of shooting, players reduce the speed of their lower limbs. This corresponds to the concentrated support on the anteriorly placed lower limb. The shaded rectangles indicate the significant coefficients between the samples involved in the study. Thus, for player #1, it is characteristic that the linear speed of the stick relative to the wrist relates (0.895), relative to the elbow (0.795), relative to the shoulder (0.877), relative to the right knee, foot, left knee, and left foot.

Regression analysis allowed the formation of an equation involving club speed versus wrist, right knee, and left foot speeds. The negative sign in front of the left knee part of the equation means that to increase the speed of the ball, the left knee must not move. This corresponds to the execution technique in field hockey.

Table 3. *Average values at the moment of impact (player #2)*

player #2	Stick [m/s]	wrist [m/s]	elbow m/s]	shoulder [m/s]	Right knee [m/s]	Right foot [m/s]	Left knee m/s]	Left foot [m/s]
X	15.91	6.55	4.24	2.59	1.02	1.46	0.24	-0.14

Table 4. *Correlation Chart (Player #2)*

player #2	stick							
Wrist	.553**	wrist						
Elbow	.353**	.577**	elbow					
Shoulder	.504**	.409**	.565**	shoulder				
Right knee	.135	.311*	.323*	.309*	Right knee			
Right foot	.339**	.438**	.607**	.336**	.477**	Right foot		
Left knee	-.004	-.300*	-.028	.043	-.042	-.085	Left knee	
Left foot	.004	-.158	-.018	.029	.139	-.101	-.008	Left foot

Regression equation (Player #2)

$$V\ stick=6{,}991 + 0{,}711*V\ wrist + 1{,}646*V\ shoulder \quad (2)$$

Table 5. *Average values at the moment of impact (player #2)*

player #3	Stick [m/s]	wrist [m/s]	elbow m/s]	shoulder [m/s]	Right tknee [m/s]	Right foot [m/s]	Left knee m/s]	Left foot [m/s]
X	17.96	6.89	5.78	2.65	0.86	1.13	-0.55	0.79

Table 6. *Correlation Chart (Player #3)*

Player #3	stick							
wrist	.491**	wrist						
elbow	.606**	.486**	elbow					
shoulder	.497**	.527**	.726**	shoulder				
Right knee	.228	.430**	.135	.151	Right knee			
Right foot	.113	.323**	.347**	.319**	.210	Right foot		
left knee	-.193	.163	-.436**	-.337**	.159	.205	Left knee	
left foot	.249*	-.153	-.306**	-.284*	-.068	-.116	.160	Left foot

Regression equation (Player #3)

*Vball= 2,468 + 1,743*V elbow +1 ,355*V left foot + 0,630*V wrist* (3)

Table 7. *Values at the moment of impact (player #4)*

player #4	Stick [m/s]	wrist [m/s]	elbow m/s]	shoulder [m/s]	Right knee [m/s]	Right foot [m/s]	Left knee m/s]	Left foot [m/s]
X	19.26	5.35	3.15	1.52	0.64	1.50	0.85	0.18

Table 8. *Correlation Chart (Player #4)*

player #4	stick							
Wrist	.527**	wrist						
Elbow	.435**	.216	elbow					
shoulder	.116	.292*	.143	shoulder				
Right knee	.336*	.243	.070	.017	Right knee			
Right foot	.401**	.224	.341**	.423**	-.062	Right foot		
Left knee	.278*	.084	-.115	.340**	.135	.406**	Left knee	
Left foot	.154	.123	.056	-.105	-.049	.050	-.092	Left foot

Regression equation (Player #4)

*Vball = 7,603 +1,256*V wrist + 1,426*V elbow + 0,763*V left knee* (4)

Table 8. *Average values at the moment of impact (player #5)*

player #5	Stick [m/s]	wrist [m/s]	elbow m/s]	shoulder [m/s]	Right knee [m/s]	Right foot [m/s]	Left knee m/s]	Left foot [m/s]
X	18.2	5.3	2.5	1.7	1.0	1.3	0.6	0.2

Table 9. *Correlation Chart (Player #5)*

player #5	stick							
Wrist	.540**	wrist						
elbow	.676**	.488**	elbow					
Shoulder	.368**	.399**	.169	shoulder				
Right knee	-.029	.184	-.212	.506**	Right knee			
Right foot	.332**	.427**	.440**	.227	-.235	Right foot		
Left knee	.087	.159	.171	.107	-.216	.345**	Left knee	
Left foot	-.150	-.173	-.114	-.157	-.167	-.175	.208	Left foot

Regression equation (Player #5)

$$V\ ball = 12{,}675 + 1{,}279 * V\ elbow + 1{,}396 * V\ shoulder \quad (5)$$

Table 10. *Average values at the moment of impact (player #6)*

player #6	Stick [m/s]	wrist [m/s]	elbow m/s]	shoulder [m/s]	Right knee [m/s]	Right foot [m/s]	Left knee m/s]	Left foot [m/s]
X	17.1	5.3	2.4	1.0	2.1	2.0	0.5	0.0

Table 11. *Correlation Chart (Player #6).*

player #6	stick							
Wrist	.552**	wrist						
Elbow	.288*	.573**	elbow					
Shoulder	.266*	.108	.154	elbow				
Right knee	.381**	.043	.210	.251	Right knee			
Right foot	.595**	.438**	.454**	.104	.252	Right foot		
Left knee	-.356**	-.024	-.009	-.001	-.101	-.271*	Left knee	
Left foot	.012	-.135	.059	-.126	.135	.192	-.214	Left foot

Regression equation (Player #6)

$$V\ ball = 6{,}811 + 1{,}914 * V\ right\ foot + 1{,}054 * V\ wrist + 1{,}491 * V\ right\ knee - 0{,}872 * V\ left\ knee - 0{,}801 * V\ elbow \quad (6)$$

The static analysis of the kinematic characteristics at the moment of contact of the player's stick with the ball when shooting at the goal was done individually for each of the players shown, since they have an individual anatomical structure. The variation analysis indicated in the tables for each of the players informs the coach about his individual capabilities determining the athlete's effectiveness in field hockey.

Correlation characteristics indicate the degree of similarity of linear velocity data at ball impact. On the other hand, the significant correlation links indicated by the shaded rectangles in the correlation tables determine the particularly important points of the athlete's body on the joint centers when shooting.

Anatomical and biomechanical analysis of a shot in field hockey

According to the criteria of biomechanical expediency in sports biomechanics and taking into account the athlete's anatomical structure, the linear velocities in the end segments of the body depend on the coordinated work of the other parts of the human structure. Reaching maximum values is a result of accumulation of speeds in local segments. In this phase, the athlete moves forward to assume the optimal striking position. The position is lateral to the target with the lead side opposite the lead hand in the grip. The position is with a slight flexion / about 30 degrees/ in the knees and greater flexion in the hip joints / about 70 degrees/. The movement continues with a lateral movement until the position is taken to execute the main phase, with the foot of the lower limb opposite the target taking a position in line with the ball. From this moment the main phase begins.

Main phase

In this phase, the lower limb opposite to the target performs a powerful push-off from the support

with contraction of the quad. femoris while the external rotators in the TBS rotate the pelvis with the leading limb positioned frontally against the direction of impact.

Fixation of the lead limb to the support creates a fulcrum of the foot with about 90 degrees of flexion at the knee and hip joint, held by isometric contraction of the extensors at these joints. This turns the femoral head into the center of rotation of the pelvis as initiation begins with adduction and internal rotator movement in the shoulder joint of the lead upper extremity in synchronization with abduction and external rotator movements in the shoulder joint of the opposite upper extremity. These movements are not large in volume/ as in golf, for example.

But they initiate a rotation of the shoulder girdle, which is followed by rotation of the spine and complemented by internal rotation at the hip joint of the lead limb. The contraction of the muscles performing these movements is synchronous and with minimal concentricity. It is united by the general grip of the stick. What is interesting about this stroke is that the motions in the high-volume joints such as the shoulder, elbow, and wrist joints are far from their maximum values.

The development of the power during the impact and of course its technical performance is the result of the precise sequential inclusion of muscles that have a greater relation to the maintenance of the posture - paravertebral muscles, abdominal muscles, iliopsoas muscle. Permanent stabilization of the pelvis is carried out by mm. glutes and adductor muscles in the hip joint. The adductor muscles in the hip joint, which have internal rotatory activity, participate in the rotation of the pelvis throughout the main phase of the stroke.

Final /amortization phase/

It includes the antagonists, which, through a gradually developing eccentric contraction at the end of this phase, slow down the movement speed. In this way, the restoration of body balance and readiness for subsequent game actions is achieved. Achieving precision execution is the result of perfecting muscle interaction. It is an expression of the internal proprioceptive muscle control system. During the performance, the athlete also has constant visual contact with the ball, determining the positioning of the leading lower limb in a way that allows the realization of maximum power and accuracy.

In this sense, muscle control is directly related to the so-called external movement control systems, part of which is the visual analyzer. In the preparatory and main phase, the player has constant visual contact with the ball. Eye contact is redirected at the very end of the main phase.

Analysis of this shot in field hockey defines it as a complex movement with tightly coordinated muscle action. In this sense, the establishment of motor habit resistance can be an indicator of training impact assessment.

CONCLUSIONS

1. A thorough kinematic analysis of the field hockey player's motor activity at the moment of impact contact with the ball when shooting at the goal was performed.
2. On the basis of the obtained individual data, statistical analyzes including variation, correlation, and regression analysis were made.
3. Through the regression analysis, the preferential participation of the segments of the athlete's body were determined.
4. The anatomical and biomechanical analysis determines the direction for an individual approach to refine the sports-pedagogical activity.

REFERENCES

Eskiyecek, G. C., Bingul, B. M., Bulgan, C., Aydin, M. (2018). 3D Biomechanical analysis of targeted and non-jargeted drag flick shooting technique in field hockey, *Acta Kinesiolodica*, Vol. 12, No. 2, pp. 13-19.

Ibrahim, R., Faber, S., Kingma I., Jaap H. van Dieen, (2017). Kinematic analysis of the drag flick in field hockey, Sports Biomechanics, *Journal of the International Society of Biomechanics in Sports*, Issue 1, Volume 16, pp 45-57, 2017

Swarén, M., Söhnlein, Q., Stöggl, T., & Björklund, G. (2019). Using 3D motion capture to analyse ice hockey shooting technique on Ice. *Proceedings of the 7th International Conference on Sport Sciences Research and Technology Support*. https://doi.org/10.5220/0008351602040208

Meulman, H.N., Berger, M.A.M., van der Zande, Ir. M. E., Kok, P.M., Ottevanger, E.J.C., Crucq, M.B. (2012). Development of tool for training the drag flick penalty corner in field hockey, 9th Conference of the International Sports Engineering Assosiation (ISEA), *Procedia Engineering*, Vol. 34, pp. 508-513, Elsevier Ltd.

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INFORMATIONAL, TERMINOLOGICAL, AND EDUCATIONAL PRINCIPLES AS A SYSTEM TO TRAIN KARATE STUDENTS AT UNIVERSITY

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ABSTRACT
At the beginning of the third millennium in Kazakhstan, the reform of the education system continued, including the concept of development of the theory, methodology, and terminology of physical education. To a large extent, this issue has touched on the training and retraining of teachers and trainers with higher education – national sports, including the national martial arts of the East.
The analysis of scientific and theoretical-practical modern educational (OP) training of Bachelor of Physical culture and sports specializing in martial arts and, in particular, in karate, allows us to conclude that it is necessary to improve training in sports concepts and terms not only in the original language (in this case - Japanese), but also in the languages of students - Kazakh, Russian, English.
The proposed article summarizes the experience of modern developments of domestic and foreign researchers in the field of information and terminological foundations for the training of Karate Bachelors while studying at a university. The most urgent problems related to teaching students the special sports terms used in modern karate are considered.

Keywords: *educational programs, bushido, budo, information, and terminological foundations*

INTRODUCTION

Since the third millennium in Kazakhstan, education reform has proceeded, including the concept advances, in theory, methodology, and terminology used in various sports. Generally, this problem has affected Bachelor's training, as well as advanced training of university-educated masters and trainers in karate. Scientific research involving the origin, formation, and improvement of physical culture and sports are important factors in the development of any society and state. So, running this research, focusing only on the Japanese karate martial arts, it should be noted that historically in some Eastern regions of the world, or rather in the Pacific Basin, even more in Okinawa archipelago of great Japan antiquity, the first Ryu served as a powerful impetus to develop physical and intellectual potential among the people living there. As a rule, they lived at a monastery, where both masters and students were monks who devoted most of their lives to all kinds of religious rituals based on physical exercises, including the art of self-defense.

So, most of the ancient martial arts, later integrated into combat sports, originated in these religious and cult centers. Id., when a ryu was established, the first masters had been going to come along followed by their adherents, propagating their skills but just among co-religionists. It should be noted that this educational system has practically survived, i.e., from master to student. On the one hand, it was used as a methodological background to train in several Eastern countries and the disciplines, including Natural Science, Physical Education, and later Sports. However, on the other hand, all this self-isolation closely managed martial arts outside Japan.

"Ryu is historically a result of a highly developed civilization. They developed later and then, wherever and during the codification of empirically established effective combat techniques, masters originated, military codes were created like several oaths, and all this was united by an individual ceremonial..." (Tarasa, 2003).

"As to general social terms, ancient martial arts, both before and now, are integral to the social environment. As part of the educational and scientific discipline, they are due to objective processes to be originated and developed by physical culture and sports among different nations, in different historical epochs based on methodology and in a targeted, practical reflection <...> and would be imperfect without a role conception of the

national cultural tradition in it. And this mostly leads to the origins of one or another martial art transformed over time into one or another kind of sport." (Boldyrev, 2018).

It has been possible to keep and enlarge this cultural tradition for many centuries, mostly due to a unique optimistic philosophy and the national cultural tradition of martial arts. There is no way for a human idea to reach the limit and distance, but there are quite a lot of barriers and obstacles. No matter how far out it was, this includes all kinds of traditions formed over the course of many centuries. Personal identification is impossible on its own, they help to choose a way, but on the other hand, they are the ones who need integration over time.

Even academic philosophers sometimes forget the fact that "an expressed idea is a lie". Let us take, for example, just one philosophical formula: "You could not step twice into the same river/In idem flumen bis non descendimus" (Heraclitus). On the one hand, nothing is constant. However, water, air, and the starry sky above are one quintessentially has the same qualities and properties. So, if you wish to "imagine the ocean, it is enough to peer closely into a drop of water". In its general concept, water is the ocean, sea, lake, river, stream, a drop dripping from a tap. Moreover, whenever we touch, take and dip into it, we are once again, like twice, three times, four times, etc., dipping into the same substance, water.

There is no willingness to change yourself rather easily as required by running time, and it is the major disadvantage of the tradition in physical culture and sports. However, everything around us changes just every minute. Nature does not tolerate static. It is always dynamic. Anyone who lags behind its movement risks death. However, Seneca, an ancient philosopher, said, "If one does not know to which port one is sailing, no wind is favorable." So, background, including traditional ancestral experience, no significant secure dogma, but greatly multiplied by new realities, both in theory and in practice, is manpower. It is his way to the port.

And what about those who are young and unskilled in everyday (practical) and philosophical (theoretical) ups and downs of life struggle? First, we should get Chinese wisdom stating that "The journey of a thousand miles begins with one step". But both the first and next steps are impossible without similar philosophical judgments and skills, and not only developed by a millennial experience of humankind but also gained via advanced training. Moreover, many experiences this process throughout their lives.

This paper aims to study the current state, content, and scientific support of the information and terminological foundations in the educational process at the university for the educational training of a bachelors' specializing in karate.

The research objective is to study the status, content, and scientific support of the information and terminological principles in the educational process at university under the educational training of a Bachelors' in karate.

The research hypothesis is the assumption that objective scientific-based research on the integration of the ancient martial art of karate-do into modern karate martial arts is available just using in the experimental and educational process wealth of modern techniques and training methods, including the information and terminological elements of karate in the language of students.

So, taking all these points together, the author of the research believes that the comprehensive integrative training of Bachelors' in karate at a high level of physical, technical, philosophical, psychological, mediative, informational, and terminological principles of the educational process is an objective liability when studying at university.

Research methods:

The objectives have marked the totality of research methods. As part of them:

- Document and Literature Analysis.
- Educational Observations and Experiments.
- Methods of Mathematical Statistics.

METHOD

Karate Bachelors', Candidate Masters' of Sports, and first-rate sportsmen took part in the educational experiment among a 24-strong crew, who were divided into 2 equivalent random groups – pilot and test. All participants studied have signed an informed agreement that the information received

from the tests will be used in the present survey. Pilot students were taught using Japanese terms in Kazakh transcription. Standard Japanese terminology was used for test students. At the same time, we emphasized that both pilot and test groups consisted of students studying at university in Kazakh and Russian in equal proportions.

There was the following objective of the scientific and educational research performed:
1. To qualify the influence of information and terminological concepts used in karate in the language of instruction at university (Kazakh or Russian).
2. To improve the effectiveness of the motivational component of the karate training process at university, integrated into the modern bachelor's educational program.

This scientific agenda was devoted to educational research experiments. It solved the problem of proving the motivational effects of the students involved, coupled with the active study of the basic terminological concepts of the karate discipline in the language of students (Kazakh and Russian). It was experimented on in the 2020-2021 academic year.
All examinees were tested before to qualify for the motivational personal orientation (T. Ehlers discipline, 2001), allowing to study of the value motivations of students for active karate classes. Moreover, we found it necessary to modernize this methodology including 5 new motivational values related to physical education and sports in the list.

T. Ehlers Questionnaire includes 32 judgments to which the examinee answered: "Yes" (+) or "No" (-). The examinee was added one point for 19 judgments with the answer "Yes" and 6 judgments with the answer "No". Seven answers were not rated. We used questions during the experiment to assess power motivation to achieve success in karate bachelor's degree programs at university. This technique allowed us to indirectly reach some psychological parameters of the bachelor's qualification. So, the following research keys and standards have been used.

High level of commitment to master basic concepts of the future profession was qualified by matching questions using similar keys marked (+) and (-). Answers marked (+) were numbered 1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 17, 18, 20, 21, 22, 23, 24, 25, 27, 29, 32. And answers marked (-) were numbered 5, 10, 15, 16, 19, 26, 28, 30, 31.

RESULTS

The results confirmed the research hypothesis based on educational observations and using methods of mathematical statistics (Table 1).

Table 1. *Language impact of learning terminology on motivation level in training Karate Bachelor at university*

Group	n	Motivation level) points(				Growth difference between groups
		Original		Final		
		X	S	X	S	
Pilot	12	12.6	1.4	18.8	1.9	P05. >
Test	12	12.7	1.3	15.2	2.1	
P	-	P05. <	-	P05. >	-	-

These findings indicate that previously identified baseline motivation levels to be successful in educational and training activities in both groups, the test subjects were on average. After the experiment, these rates increased in both groups. However, in the pilot group, the increase in motivation was higher than in test one at $P < .05$. Indicators received during the experiment confirm that mastering sports and technical terminology of karate in the languages of instruction at university (Kazakh, Russian) positively affect the psychological sphere of students, increasing their motivation for systematic training exercises.

In our opinion, this is because students who know sports terminology in the language of instruction at university are more motivated by their learning outcomes and are able to be more active in training and sports. All this leads to an increase in their achievements in learning and sports. Thus, we have been able to establish a reliable relationship between qualitative information and terminolog-

ical and educational principles like methods and techniques of bachelor's degree training. Findings, inter alia, confirm the motivation, reliability, and progress of educational experiments conducted and their conformity with the goals and objectives of scientific research.

DISCUSSION

Perfect, competent information and communication component is an important factor in studying at university and supports effective mastery of one or another physical culture and sports discipline in almost any sport, including karate. For the teacher (coach), where the process starts and ends. This process refers to educational and terminological principles of cognition studied at university.

If you want to update this statement, it is enough to refer to "Concise Sociology Dictionary". It states that "Social information is a baggage formed and reflected in society using various subjects to regulate social interaction, social relations and relations between man, society and nature." Sociological information received and interpreted as part of sociological science is an integral part of it." (Pavlenok, 2001). This interpretation is closely related to physical culture and sports since it is a social institution of modern society.

Research factors of ancient martial arts allowed the authors to make an unambiguous conclusion: today, there are two widespread but autonomous styles in the world. Karate as an ancient martial art can be roughly described as "karate-do" and karate as a modern sport, or "sports karate". Both of these directions have the same "root" system, which, however, does not take root well in the strange background. Here, we are talking about the educational training of students. This duality imparts a philosophical and, at the same time, existential (subjective idealism) quality to the scientific research we are studying.

Many foreign researchers (Yamaguchi, 1998; Mikryukov, 2009; Hassell, Otis, 2009; Hilli, 2015; Beneke, et al., 2004) believe that the popularity of karate-do is explained by rather different factors, among which the information and communication ones function as leading factors. Tens and thousands of adherents of this ancient martial art and modern combat sports from all over the world are actively studying karate. Moreover, the result is not immediately successful but makes it last for many years. Such varied, at times confused (man who does not own the Japanese logic of thinking) educational structure also puts increased demands upon academic programs for training Karate Bachelors at university (Yamaguchi, 1998; Mikryukov, 2009; Hassell, 2009; Hilly, 2015; Beneke, et al., 2004).

As you know, sports karate became world-famous only in the first half of the twentieth century, and the process of its final formation remains unfinished. This results in search for the visual balance and highest level of athletes' safety in competitions and training, that has been going on throughout sports karate history. At the same time, this is reflected in studying and improving used information and terminological concepts of karate. Thus, there are many reasons why the IOC does not include karate in the official program of the Olympic Games up to the present time. Changes and updates are regularly being made, sometimes quite radical, but it has the main goal to improve the spectacle of karate competition. So, there are requirements from authorized organizations that greatly affect the integrative processes when students master as many styles and schools of modern sports karate as possible at university.

Thus, we have the right to assert there are two directions in modern karate that possess their own rather individual sub-aspects and school spirit. At the same time, many researchers and experts believe that way towards success in sports karate "has a number of challenges expressed in specific indicators modeling the desired attributes of athlete, goal setting for all types of upcoming training, choice of manner, methods and values of loads, its distribution according to form of the educational process and training days…" (Koller, 1993). If you want to comprehend the secrets of karate, as well as any other martial arts, you should develop your ambition, courage, and purpose, improve the moral, goal-oriented, and physical potential of an individual, and, at the same time, push the boundaries of the philosophical and moral manifestation of Karate art.

Today, there are several hundred styles of karate. Endless disputes about the advantages or disadvantages of a style have been going on for many years (Table 2).

Table 2. *Classifier of ancient ryu and style according to which Karate Bachelors are being trained in the Republic of Kazakhstan at the present time*

Training features of martial arts in the past	Class, style, and school from the days of its origin to the modern times	Integrated training features of Bachelors	Gender
1	2	3	4
Overall and specialized training. **Training** in basic combination techniques and tactics. Free Combat **Training** (kumite). **Training** of shock body parts. **Breaking** hard objects. Impact **resistance**. **A form** of meditation. Combat **tactics** with opponents of different qualifications. **Training** with heavy objects. **Power** to strike first. **Features of striking techniques: Kime —** energy concentration when striking or block setting. **Jein —** powerful fighting spirit. **Hara —** combining inner energy with muscle strength. **Dachi (tachi) —** selection of the most appropriate positions.	**WKF Karate** 520 AD China, India, Okinawa. Then in 1922, Japan	WKF sports karate. Shock-throw, combined with a tough-soft style.	M-W
	Karate daido-juku kudo 17th century, Japan 1970, Japan	Combination of ju-do and karate, full contact. Tough style.	M-W
	Karate-do Shotokan. 1920, Japan	Limited contact Classic striking style	M-W
	Karate-do Shinkio-Kushinkai 2003, Japan	Full contact. Hard impact technique.	M-W
	Karate-do Kekushinkai 1965, Japan	Full contact. Hard impact technique	M-W
	Karate-do-goju-ryu Second half of 19th century	Full contact. Hard impact technique	M-W
	Ashihara Karate 1980, Japan	Strike-throw technique, full contact	M-W
	Shito-ryu (Sito-ryu) 1931, Japan	Limited contact, impact technique with elements of throwing one	M-W

Besides, martial arts have their own original terminology, which helps athletes, coaches, and sports referees to communicate more comfortably with each other. That is why it is important to systematize the structural construction of terminology support when teaching students at university and in Kazakh and Russian languages. So, the authors of the article have created a dictionary of terms and words used in training sports karate. It includes more than 350 words used in teaching students at university and refereeing competitions, including:

- Common Karate Terms and Concepts
- Terminology used in the training process
- General instructions during training and competitions
- Technical terms following the process of study at the university
- Terms and concepts related to refereeing competitions

Absolute truth or even an axiom is that the basic mental difference between a human and an animal is the second signaling system. When you talk, you can understand and communicate with your peers. It is not surprising, therefore, but the ability to speak, even internationally, or translate in the language of instruction, at least in some sports terms, has a positive impact on the educational training of Bachelors.

It is also essential to acquire and learn the laws of the functioning of the human body, its redundancy, and its reactions to muscular loads in the educational training system of Bachelor of Physical culture and sports to academic knowledge. The main aims of training in karate and other types of martial arts are:

- Preservation and promotion of health.
- To increase the body's resistance to infectious, climatic, and other environmental hazards;
- Improving physical and mental capacity;
- Increased distress tolerance and indicators in studies and sports.

However, a high degree of success in achieving all these objectives is only possible with a rational, theoretically sound, complex impact on students. As a result, a modern Bachelor (master and trainer in physical education and sports) should have not only clear ideas about his subject but also the required knowl-

edge of IT terminology. It should be emphasized that these days, the organization of the educational process at university requires the study and application of transcriptions of particular terms so as to improve karate training in Kazakh and Russian.

The role and meaning of foreign terminology when studying at university were investigated at the time by V. S. Kozlov, a Professor of the Kazakh Academy of Sports and Tourism, Candidate in Philological Sciences. He argued that students' growing interest in studying foreign languages professionally and related terms is largely due to, on the one hand, there is an increasing demand for young graduates of higher education and, on the other hand, ever closer contacts and commercial ties with foreign countries. Language is an instrument of communication. Language is a symbolic system. The sound sign functions as a triune unit of vocabulary, morphology, and syntax within the graphic and sound. Language is a system serving speech, whereby we must meet the meaning communicated to students. This is a source for language as communication. Creation of natural communication situations, including during the training process, should run through all stages of training" (Kozlov, 2001).

CONCLUSION

The following conclusions emerged from the pilot studies.

1. Karate Bachelor's degree training requires to use of integral teaching methods, including information and terminology support training.
2. When training karate beginners, a coach-instructor should recognize traditional degree and rank practice, student "kyu" and "dan" skills, analogous to their color belts, and basic terminology.
3. Structural styling and qualification features of modern styles and karate schools have a varied impact on the educational level of karate.
4. Improving the motivational factor in the training activities of bachelor's is an important aspect of their professional training.
5. The development of educational programs for the training of karate students should be put into practice science-based recommendations and principles, proven methods, rules, and techniques, and in the language of instruction.
6. It should be recognized that the training of Bachelor' martial arts for students in universities of Kazakhstan does not meet all the requirements for the current level to develop these martial arts.
7. Research is made to prove that the use of physical culture, sports, information and educational terms in the modern teaching process during training for karate bachelors at university is imperative.

REFERENCES

Boldyrev, B. N., Sanauov J. A. (2018). Nachionalnaya kulturno-sportivnaya tradichya i sovremennoe sportivnoe dvijenya Kazakhstana. *Nauka, praktika, vospitanie*., s. 58.

Hassel, R. Dzh., E. Otis. (2009). *Polnyy kurs karate s illyustratsiyami: per. s angl*. Moskva: AST Astrel.

Hilly, K. (2015). *Karate*. Moskva: Eksimo-press.

Koller, V. S., V. N. Platonov (1993). *Teretiko-metodicheskiye osnovy podgotovki sportsmenov*. L'vov.

Kozlov, V. S. (2001). Vybor optimal'nykh metodik dlya povyvsheniya effektivnosti uchebnogo protsessa. *Teoriya i metodika fizicheskoy kul'tury*, № 2, s. 17-21.

Mikryukov, V. Yu. (2009). *Karate-do*. Uchebnoye posobiye, Moskva: AST Astrel.

Pavlenok, P. D. (2001). *Kratkii slovar' po sociologii*. Moskva.: Infra-M.

Tarasa, A. Ye. (2003). *Boevye i sportivnye edinoborstva*. Sprovochnik, Yan.: Harvest.

Yamagychi, N. (1998). *Fundamentalnoe karate.* Moskva: Grand.

Beneke R., et al. (2004). Energetics of karate kumite. *Eur J Appel Phyisol.* Vol 92, pp. 518-523.

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TRENDS AND EFFORT DISTRIBUTION OF MEN'S 50 KM RACE WALKING

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ABSTRACT
Race walking has been a highly technical event in the Olympic games since 1908. In the whole history of the discipline, the rules of walking define the technique and respectively the result. Since the last change of the rules in 1996, the results in 50 km race walking have constantly developed. No matter the facts, the Olympic committee decided to change the race distance to 35 km. The research aims to find reasons why they did this by analyzing the effort distribution of elite race-walking competitors in major championships. Tasks of the research are: 1) To analyze the development of the results in world championships; 2) To research some trends in effort distribution of elite race walkers. Methods: To accomplish the research task, we made a literature review and statistical analyses of the data of the last five major championships. Result: The champions have greater average speed than the other athletes. All of the first ten competitors have negative splits e.g., faster second half of the race but the medalists are the only athletes that maintain a speed that is similar to their average in the last 10-15 km. The leaders in the ranking have slower starting splits than the other walkers. Conclusion: Better results can be achieved if the athlete starts a little bit slower than the average speed and steadily increases it till the end of the race as much as possible.

Keywords: *world championships; results; race walking; splits*

INTRODUCTION

Race walking has been one of the constant disciplines in the Olympic games since 1908. At the same time, it is one of the most controversial ones because it is the only discipline in which judges can influence the final ranking. We can confirm that with numerous competitions in its history (Salvage, 2013; Erickson, 2020). One of the major factors of the final results is the technique which is constantly changed over the years. The last change dates back to 1996 and race walking is defined as: a progression of steps so taken that the walker makes contact with the ground so that no visible (to the human eye) loss of contact occurs. The advancing leg shall be straightened (i.e., not bent at the knee) from the moment of first contact with the ground until the vertical upright position (Salvage, 2013; Erickson, 2020; World athletics, 2022). From that point onwards the results have improved constantly. Regardless of these facts, the Olympic committee decided to change the race distance to 35 km. Previous researches on race walking effort distribution showed interesting results (Padulo et.al, 2013; Pavei et.al, 2014; Cazzola et.al, 2016; Pavei and La Torre, 2016; Pavei et.al, 2019; Peev, 2021). The current research focuses on the 50 km race walking discipline that had its last Olympic champion in Tokyo 2020. In this report, we aim to find out why the Olympic committee changed the race distance as we analyze the effort distribution of elite race-walking competitors in major championships.

The first task of the research is to analyze the development of the results in World championships, and the second task is to research some trends in the effort distribution of elite race walkers.

METHODS

The methods used in the current research are: literature review and statistical procedures (descriptive statistics). The data of the results in 50 km race walking (final result and splits) of the athletes were received from the official statistics of the World athletics for the World Championships in the last 10 years (2011-2019). The results of the last 4 championships were separated into four groups based on the final position in the discipline as follows: first, medalists, competitors placed till 10th and competitors placed till 20th. Based on their times on every 5 km splits we calculate the average speed for every athlete throughout the whole distance.

RESULTS

The dynamics of the results of male 50 km race walking are shown in Table 1. It is obvious from the table that the champion's result is between 3:33:42 h and 4:04:20 h with an average value of around 3:44:01 hours. This result is 5,66% weaker than the world record. The time needed for a medal in this event is around 3:47:06 hour. A great deviation from this trend can be seen in Doha championship which is the championship with the weakest results.

Table 1. *Achieved results in World athletics championships in 50 km race walking - men*

Championship ⇨ / Position ⇩	Helsinki - 1983	Rome - 1987	Tokyo - 1991	Stuttgart - 1993	Goteborg - 1995	Athens - 1997	Seville - 1999
First place	3:43:08	3:40:53	3:53:09	3:41:41	3:43:42	3:44:46	3:47:54
Third place	3:49:03	3:44:02	3:55:14	3:42:50	3:45:57	3:48:30	3:50:55
Tenth place	3:57:25	3:52:21	4:09:18	3:52:50	3:53:23	3:54:28	3:57:11
Twentieth place	4:08:11	4:00:10	4:29:45	4:03:22	4:06:08	4:05:09	4:05:58

Table 1. – *sequel*

Edmonton - 2001	Paris - 2003	Helsinki - 2005	Osaka - 2007	Berlin - 2009	Daegu - 2011	Moscow - 2013	Beijing - 2015	London - 2017	Doha - 2019
3:42:08	3:36:03	3:38:08	3:43:53	3:41:16	3:42:45	3:37:56	3:40:32	3:33:42	4:04:20
3:46:12	3:37:46	3:41:54	3:44:38	3:42:34	3:44:40	3:40:39	3:42:55	3:41:19	4:05:02
3:53:25	3:49:05	3:55:02	3:58:22	3:48:52	3:49:32	3:45:56	3:48:48	3:45:28	4:13:56
3:59:57		4:08:12	4:07:14	3:57:53	3:56:41	3:51:00	3:55:43	3:51:17	4:25:36

Figure 1 shows a visible trend that in every championship, the results had a similar tendency of increasing and decreasing according to the best time. This can be due to weather conditions, pace, or some other factors that cannot be determined so easily.

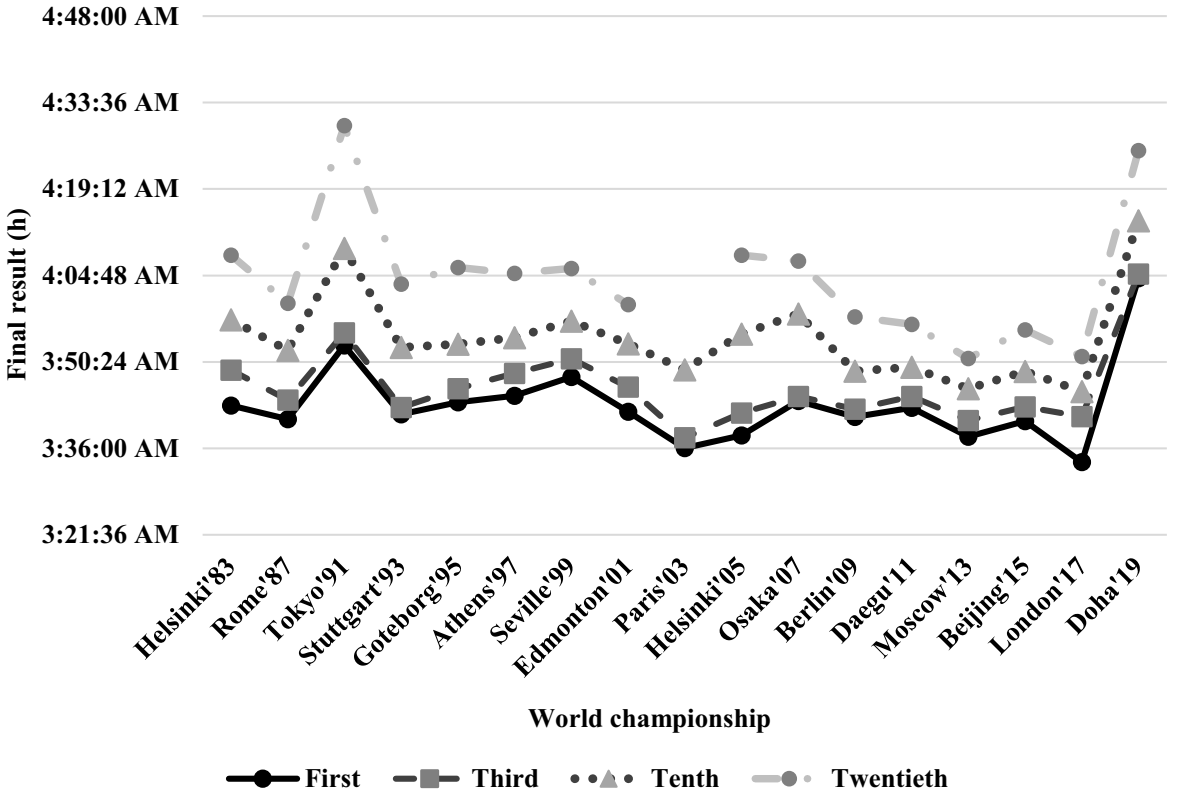

Figure 1. *Dynamics of the result in male 50 km race walking in World championships*

The average pace to qualify in some of the above-mentioned categories is shown in Table 2. Champion's speed is the highest among the athletes and its value must be around 13,43 km/h or higher. The average speed decreases when an athlete is in position for a medal and gets even lower when they qualify among the first 10 or 20 competitors.

Table 2. *Average walking speed across various groups of competitors.*

Ranking	Average speed (km/h)
First place	13.43
Third place	13.21
Tenth place	13.02
Twentieth place	12.62

DISCUSSION

As we already reported, the reason for this decrease is due to the extremely high temperature. Such a conclusion was supported by other authors and analyses in this research in Table 3 (Rushall, Pyke, 1990; Maughan, Shirreffs, 2004; Zhelyazkov, Dasheva, 2011; Peev, 2021). We can go even deeper with these analyses as we state that the unusual starting time (r = .884) and extreme heat (r=0,992) are two of the major limiting factors for the final result. Most of the authors consider the temperature around 10-17° as optimal for endurance competitions (Rushall, Pyke, 1990; Maughan, Shirreffs, 2004).

Table 3. *The weather condition of competing in the 50 km race walking in the World Championship*

World Championship	Starting time	Temperature (°)	Humidity (%)	Result
Doha'19	23:30	31	74	4:04:20
London'17	07:46	14	72	3:33:42
Beijing'15	07:30	22	78	3:40:32
Moscow'13	08:28	17	84	3:37:56
Daegu'11	07:57	23	73	3:42:45
Berlin'09	09:09	20	68	3:41:16
Osaka'07	07:00	25	80	3:43:53
Helsinki'05	11:35	16	94	3:38:08

In order to optimize the performance, some authors research models for the prediction of the race walking result on a shorter than competitions distance (Drake et.al, 2009; Przednowek, Wiktorowicz, 2013; Wiktorowicz et.al, 2015; Di Gironimo et.al, 2016). Others try to disclose some performance patterns in official competitions and even some tactical approaches in the race (Slavchev, Ivanova, 2003; Slavchev, Dagoglu, 2003; Slavchev, 2004; Hanley, 2013)

A basic kinematic characteristic of race walking is the average speed which is defined by the walking stride and frequency. There is a lot of research on this subject (Phillips, 1984; Petrov, 2001; Hanley et.al, 2008) but obtained speed results in table 2 are different from others on the same topic (Phillips, 1984; Petrov, 2001).

The result in Figure 2 shows that the first 3 athletes compete with an expressed negative split between the first and second halves of the distance, which is a normal trend in all the distances in race walking (Hanley, 2013; Peev, 2021). The competitors that are among the first 10 in the final show the same trend but with a slightly faster second part of the distance (46 seconds). On the contrary, the athletes that are at the bottom of the table have a slower second part of the race.

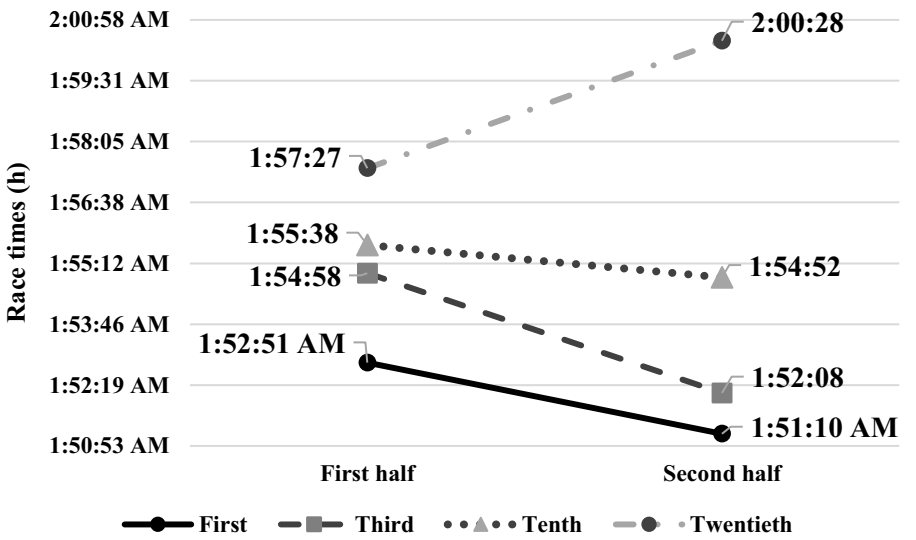

Figure 2. *Effort distribution dynamics of 50 km race walking times*

Thanks to the statistical data from the World championships we can make detailed analyses of the speed of every 5 and 10 km of the competition distance (Figures 3 and 4).

It is obvious from the figure that the champions start with a relatively slow pace and start increasing it gradually until around 40 km then slow down to the average speed. This decrease, in the end, maybe due to fatigue or just a tactical approach that aims to eliminate the chance of being disqualified. The medalists, on the other hand, start relatively slow and increase the speed at every 10 km distance. Some authors stated that this is a normal pacing strategy to avoid carbohydrate depletion and lactate accumulation in the blood (Abbiss, Laursen, 2005; 2008).

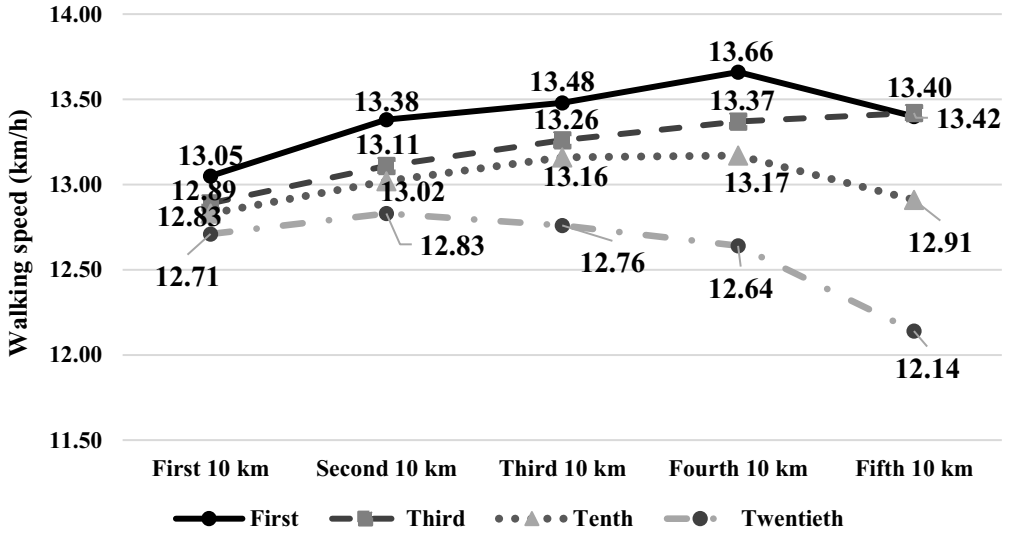

Figure 3. *Speed in different sections of the 50 km race walking*

Another option is to avoid visual contact of the judges with the group of athletes. The contenders that are ranked in the first 10 starts slow and increase the average speed until the third 10 km and then start to slow down. Reasons for this performance can be an overestimation of their current form or bad pacing strategies. The athletes that are behind 10th place in the competition start with the same speed as the others but gradually decrease it throughout the distance which is a consequence of their lower functional capacity.

Even more detailed analysis could be done from Figure 4 and Table 4 where all the splits are made of a section of 5 km. The trend is similar with the

difference that the champion usually walks with two peaks of the performance, one of which is between 20 and 25 km with a little decrease of the speed until 30th km. After this, his speed increases for another 10 km and then decreases around the average walking speed. At the same time, the athletes ranked second and third constantly increase their speed from the start to the end of the race as they finish faster than the average speed. On the other hand, competitors that finished from fourth to tenth place increased their speed to 35 km and then slow down. The athletes who placed after 10th increased their speed until 20th km and then gradually decrease it until the finish.

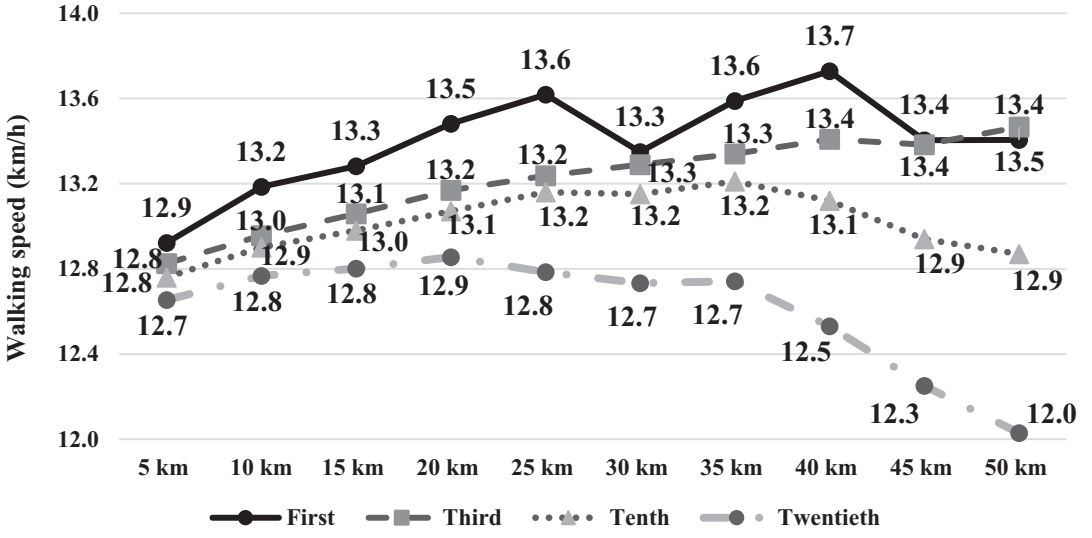

Figure 4. *Speed in different sections of the 50 km race walking*

Compared to the average speed all of the athletes among the first ten in the final ranking have a slower first 15 km than the average speed. The greatest percentage difference in the average pace (-3.78%) is registered with the champion in the first 5 km split followed by the medalists. The greatest increase in the pace in the late stages of the competition is also registered by the champions. The greatest speed difference is registered in the last two 5 km splits by the athletes ranking from 10th to 20th position.

Table 4. *Percentage difference between average speed and split average speed of different groups in men's 50 km race walking*

Split ⇨	**Percentage difference**									
Place ⇩	First 5 km	Second 5 km	Third 5 km	Fourth 5 km	Fifth 5 km	Sixth 5 km	Seventh 5 km	Eight 5 km	Ninth 5 km	Tenth 5 km
First	-3.78	-1.82	-1.10	+0.39	+1.41	+0.60	+1.18	+2.22	-0.19	-0.18
Third	-2.93	-1.95	-1.17	-0.33	+0.18	-0.58	+0.96	+1.48	+1.29	+1.91
Tenth	-2.00	-0.92	-0.31	+0.38	+1.08	+1.00	+1.46	+0.77	-0.61	-1.15
Twentieth	+0.31	+1.21	+1.48	+1.90	+1.35	+0.94	+1.01	-0.67	-2.89	-4.64

In summary, we can claim that all of the athletes used different performance approaches based on their current abilities and goals in the World athletics championships. The best athletes used a negative split pace. On the contrary, the athletes placed at the bottom used a steady or positive split pace. From all of the analyses, it is clear that most of the athletes are slower in the last part of the race because of a different reason. That can be one of the major factors for decreasing the competition distance for the next Olympic games.

CONCLUSION

Based on the analyses of the research it can be concluded that:

Weather conditions are a factor of great importance

for the result in race walking;
Better results can be achieved with a good pacing strategy that includes a slower starting speed which is steadily increased till the end of the race.

REFERENCES

Abbiss, C.R. & Laursen, P.B. (2005). Models to explain fatigue during prolonged endurance cycling, *Sports medicine*, pp. *35*(10): 865-898;

Abbiss, C.R. & Laursen, P.B., (2008). Describing and understanding pacing strategies during athletic competition, *Sports Medicine*, pp. *38*(3): 239-252;

Cazzola, D., Pavei, G. & Preatoni, E. (2016). Can coordination variability identify performance factors and skill level in competitive sport? The case of race walking, *Journal of Sport and Health Science*, *5*(1): 35-43;

Di Gironimo, G., Caporaso, T., Del Giudice, D.M., Tarallo, A. & Lanzotti, A. (2016). Development of a new experimental protocol for analysing the race-walking technique based on kinematic and dynamic parameters. *Procedia engineering*, pp. *147*, 741-746;

Drake, A., James, R., Cox, V., Godfre, R. & Brooks, S. (2009). Prediction of race walking performance via laboratory and field tests, *New Studies in Athletics,* pp. 23(4): 35-41;

Erickson, T. (2020). A Potted History of the Rules of Racewalking, available at: http://www.vrwc.org.au/vrwchistrules.shtml (accessed 28.09.2021);

Hanley, B. (2013). An analysis of pacing profiles of world-class racewalkers, *International journal of sports physiology and performance*, 8(4): 435-441.

Hanley, B.B., Drake, A. & Bissas, A. (2008). The biomechanics of elite race walking: technique analysis and the effects of fatigue, *New studies in athletics*, 4: 17-25;

Maughan, R. & Shirreffs, S. (2004). Exercise in the heat: challenges and opportunities, *Journal of Sports Sciences*, 22(10): 917-927;

Norberg, J. (2015). *Biomechanical Analysis of Race Walking Compared to Normal Walking and Running Gait,* Theses and Dissertations-Kinesiology and Health Promotion, 20;

Padulo, J, Annino, G, D'Ottavio, S, Vernillo, G, Smith, L, Migliaccio, GM, & Tihanyi, J. (2013). Footstep analysis at different slopes and speeds in elite race walking, *J Strength Cond Res,* 27(1): 125–129:

Pavei, G. & La Torre, A., (2016). The effects of speed and performance level on race walking kinematics, *Sport Sciences for Health*, 12(1): 35-47;

Pavei, G., Cazzola, D., La Torre, A. & Minetti, A.E., (2014). The biomechanics of race walking: literature overview and new insights. *European journal of sport science*, 14(7): 661-670.

Pavei, G., Cazzola, D., Torre, A.L. & Minetti, A.E., (2019), Race Walking Ground Reaction Forces at Increasing Speeds: A Comparison with Walking and Running. *Symmetry*, 11(7), p.873;

Peev, P. (2021). Tendentsii v razvitieto na distsiplinata 20 km sportno hodene za mazhe, *Leka atletika i nauka*, 1(21): 18-22;

Petrov, P. (2001). *Sportno hodene*, Bolid Ins. Sofia;

Phillips, S.J., (1984). Kinematics of race walking In *ISBS-Conference Proceedings Archive;*

Przednowek, K. & Wiktorowicz, K., (2013). Prediction of the result in race walking using regularized regression models, *Journal of Theoretical and Applied Computer Science*, 7(2): 45-58;

Rushall, B. S., & Pyke, F. S. (1990). *Training for sports and fitness:* 126-135;

Salvage, J. (2013). The history of race walking, available at: https://www.active.com/walking/articles/the-history-of-race-walking-870430 (accessed 26.09.2021);

Slavchev, A. (2004). Razpredelenie na usiliyata v sportnoto hodene na 10 km pri yunoshi i devoyki, *Sport i nauka*, pp. 4, 19 ;

Slavchev, A., Dagoglu,Y (2003). Razpredelenie na usiliyata pri sportnoto hodene na 10 km za yunoshi, *Sport i nauka*, pp. 4, 14;

Slavchev, A., Ivanova, G. (2003). Razpredelenie na usiliyata pri sportnoto hodene na 10 km za devoyki, *Leka atletika i nauka*, pp. 2/3, 35;

Wiktorowicz, K., Przednowek, K., Lassota, L. & Krzeszowski, T. (2015). Predictive modeling in race walking, *Computational Intelligence and Neuroscience.*

Zhelyazkov Tsv., Dasheva, D. (2011). *Osnovi na sportnata podgotovka*, Sofia, Gera art, Sofia;

World athletics (2022). Competition and technical rules - 2022 Edition, available at: https://www.worldathletics.org/about-iaaf/documents/book-of-rules (accessed 01.03.2022).

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SPORTS PREPAREDNESS AMONG FEMALE BASKETBALL PLAYERS UNDER 12 YEARS OF AGE

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ABSTRACT
High and stable sports results can be achieved only through well-developed and structured sports preparation. The status of the sports preparedness among adolescent female basketball players is a very accurate and objective indicator, with which we can assess the efficiency of the conducted educational and training process in basketball. The purpose of the current study is optimization of the preparation and training process for women basketball players up to 12 years old from the NSA basketball team. Based on the analysis of the players' physical development, their specific working capacity and the technical preparedness, their training programs can be updated for their future training activities. The study has been conducted in two stages – at the end of the preparation period, and during the second part of the competition period. Testing on 14 performance indicators has been carried out, which give information about the basic parameters of the sports preparedness of the tested basketball players. In order to reach the set objectives and tasks of the current study, the following research methods have been applied: research and analysis of specialized literature, 4 anthropometric and 10 sports-pedagogical tests. The achieved results from the testing have been processed by applying the T-criterion of Student, variation analysis, body-mass index and correlation analysis. The analysis of the results from the two testing sets has established that the applied training program has made positive impact over some characteristics of the sports preparedness of the basketball players. The training methods which should be applied for female basketball players at that age, have to be aiming at improving the speed of reaction, frequency of movements and the coordination abilities, together with techniques in playing offense and defense. The examined young basketball players have significantly improved their bursting power in horizontal and vertical planes. The same is noticed for their speed and the technical success in shooting while moving (successful shots on the go).

Keywords: *basketball, sports preparedness, training activity, control*

INTRODUCTION

Modern basketball is a complex process which puts itsparticipants under ever-changing conditions and game situations. Successful participation in this process requires from the young basketball players to possess extreme physical and speed-strength abilities.

In modern sports theory, more and more the opinion which prevails is that high and stable sports results can only be achieved based on well-designed and structured multi-year sports preparation (Tsankov, 2020). Functional preparedness is one of the most important traits of the multi-year sports preparation and it is the foundation upon which the sports mastership of the young women basketball players is built. Tracking the performance indicators for their physical preparedness over time allows coaches of adolescent women basketballers to objectively plan and manage the educational and training process, both for each one of the athletes (depending on their chronological and biological age), as well as for the team as a whole.

The level of progress of the physical characteristics of basketball players affects their sports preparedness. This subject has been studied by (Tsankov, Tsankova, 2013); (Tsankova-Kaloyanova, 2018).

It is a known fact that sports achievements in basketball are hugely influenced by not only the morpho-functional indicators, but also the level of development of the special physical characteristics and abilities. Their values determine to what extent the genetical predisposition of every player in combination with his or her techical-tactical preparedness will be revealed during the training process, and most of all – in competition games.

The combined exhibit of the motor qualities – speed, strength, endurance, flexibility and agility, is a common characteristic of basketball. Studying the motor activity in basketball reveals that motor skills are consistently revealed in combination and at the same time. They are expressed in a variety of sequences of moves with different time duration, space and effort. Also, the manifestation of the motor skills in basketball has a leading role in the training process.

According to (Aladzhov, 1992), physical preparation characterizes the complex manifestation of the motor skills of an athlete. Together with the rest of the sports training, it is also a necessary and indispensable element in sport activity (Karabiberov, Bonov, 2000); (Tsankov, 2005).

Aim and objectives of the study

The purpose of this study is to optimise the preparation of adolescent women basketball players under 12 years of age from the NSA basketball team. By analysing their physical development, their specific ability to work and their technical preparedness, in order to update their training programmes for their future training activities.

METHODS

The current study was conducted in two phases. The first testing was completed in September 2020, at the beginning of the sports-competition year. The second testing was done during March 2021, before the start of the qualification tournaments. The study was conducted with the consent of the athletes and their parents, who have filled in declarations of consent for participation in the process of this study.

The subject of research is the sports preparedness of adolescent women basketball players.

The object of research are the main performance indicators of physical and technical preparedness in basketball.

14 basketball players up to 12 years of age were examined.

In order to achieve the aims and objectives of this study, the following research methods are applied:

1. Studying and analysis of the specialized literature.
2. Anthropometry – to uncover the status of the main anthropometric indices. Measurements were carried out with standard instruments and by standard methodologies (Slanchev, 1998).
3. Sports-pedagogical testing – to determine the level of sports preparedness of the tested basketball players. 14 tests were used:
   - for physical development – 4 indicators (1st to 4th indicator);
   - for physical preparedness – 6 indicators (5th to 10th);
   - for technical preparedness – 4 indicators (11th to 14th).

The achieved results were processed mathematically-statistically by applying:

- T-criterion of Student – to prove the significance of the deviations between the average values of the tested indicators of our study;
- Variation analysis – to determine the average levels and the variability of the tested indicators;
- Body mass index – recommended by the World Health Organization for assessment of the nutritional status of the body (Petkov, Toteva, Maznev, 2002);
- Correlation analysis – to reveal the interdependence between the indices for the sports preparedness of the basketballers.

RESULTS

Table 1 presents the results which carry the information about the physical development, physical and technical preparedness of the basketball players at the first testing and the second testing.

In order to carry out the comparative analysis, we have used the t-criterion of Student for independent samples. The choice of this method is correct because the calculated coefficients of asymmetry and excess do not exceed the critical values at the level of significance $\alpha = .05$.

Table 1. *Sports preparedness of women basketball players under 12 y.o.*

№	Indicators	I testing		II testing		d	t	P(t)
		X_1	S_1	X_2	S_2			
1.	Height	144.06	9.12	145.57	8.59	-1.51	-4.05	99.86
2.	Weight	37.89	8.78	38.43	8.47	-0.53	-2.79	98.48
3.	Body mass index (BMI)	18.11	3.23	18.04	3.22	0.07	0.70	50.54
4.	Stretch	141.25	11.03	142.57	10.68	-1.32	-6.19	100.00
5.	Running 20m	4.13	0.41	3.95	0.39	0.18	9.80	100.00
6.	Long jump from standing pos.	143.64	16.74	148.21	14.28	-4.57	-5.04	99.98
7.	Vertical jump	22.36	2.71	23.43	2.47	-1.07	-3.74	99.75
8.	Throwing of a thick ball	374.93	128.15	399.14	112.19	-24.21	-2.89	98.73
9.	Sit-ups	15.07	2.46	13.78	2.45	1.28	4.22	99.90
10.	"Shuttle" – 112m	26.71	1.39	26.15	1.37	0.56	8.59	100.00
11.	Defensive movement T	12.20	0.59	11.81	0.50	0.40	4.28	99.91
12.	Dribble between stands	28.59	0.74	28.36	0.74	0.23	7.42	100.00
13.	Shooting the ball in motion t	38.69	1.35	38.34	1.40	0.34	5.36	99.99
14.	Shooting in motion – coefficient	12.54	3.46	11.13	2.97	1.40	1.90	92.06

The results of the applied variance analysis of baseline data from the performance testing for sports preparedness of the basketball players are presented in (Table 2).

The indicators for physical development in the first testing are stable. The most variable index is the 2nd one (Weight) with value of V=23,17% and 3 (BMI), V=17,83%. This shows that the girls basketballers are relatively homogenous in terms of their weight and body mass index. At the performance indicators for physical preparedness, the group is almost equal for indicators 6 (Long jump), 7 (Vertical jump) and indicator 9 (Sit-ups). The variation of indicator 8 (Throwing of a thick ball) is large – V=34,18%, which means that the sample is non-homogenous. The results from the variation analysis of the technical preparedness show that at the indicators "Defensive movement T" (indicator 11), "Dribble between stands" (indicator 12) and "Shooting in motion – Time" (indicator 13) – the group is strongly homogenous. At "Shooting in motion – coefficient" (indicator 14) – (V=27,59) – the group is non-homogenous.

Table 2. *Average values and variability of the indicators for sports preparedness of the women basketball players*

	First testing					Second testing				
Indicators	**X**	**S**	**As**	**Ex**	**V**	**X**	**S**	**As**	**Ex**	**V**
1. Height	144.06	9.12	-0.35	-0.76	6.33	145.57	8.59	0.09	-1.02	5.90
2. Weight	37.89	8.78	0.19	-0.31	23.17	38.43	8.47	0.09	-0.56	22.04
3. BMI	18.11	3.23	0.96	0.53	17.83	18.04	3.22	0.83	0.06	17.85
4. Stretch	141.25	11.03	-0.70	-0.27	7.81	142.57	1.68	-0.69	-0.44	7.49
5. Running 20m	4.13	0.41	0.87	0.17	9.93	3.95	0.39	0.42	-0.63	9.87
6. Long jump st.pos.	143.64	16.74	-0.32	-0.57	11.65	148.21	14.28	-0.08	-1.30	9.36
7. Vert. jump	22.36	2.71	0.34	-0.01	12.12	23.43	2.47	0.24	-0.19	10.54
8. Throwing thick ball	374.93	128.15	-0.74	-0.80	34.18	399.14	112.19	-0.74	-0.85	28.11
9. Sit-ups	15.07	2.46	0.16	-0.06	16.32	13.78	2.45	0.02	-0.98	17.78
10. "Shuttle" 112m	26.71	1.39	-0.21	0.39	5.20	26.15	1.37	-0.31	0.51	5.24
11. Defensive mov.T	12.20	0.59	-0.28	-0.94	4.84	11.80	0.50	-0.06	-0.74	4.23
12. Dribble b/n st.	28.59	0.74	-0.34	-0.82	2.59	28.36	0.74	-0.22	-0.78	2.61
13. Shoot in motion.T	38.69	1.35	0.28	-0.47	3.49	38.34	1.40	0.27	-0.50	3.65
14. Shoot in m.-coeff.	12.54	3.46	0.99	1.00	27.59	11.13	2.97	1.34	3.25	26.68

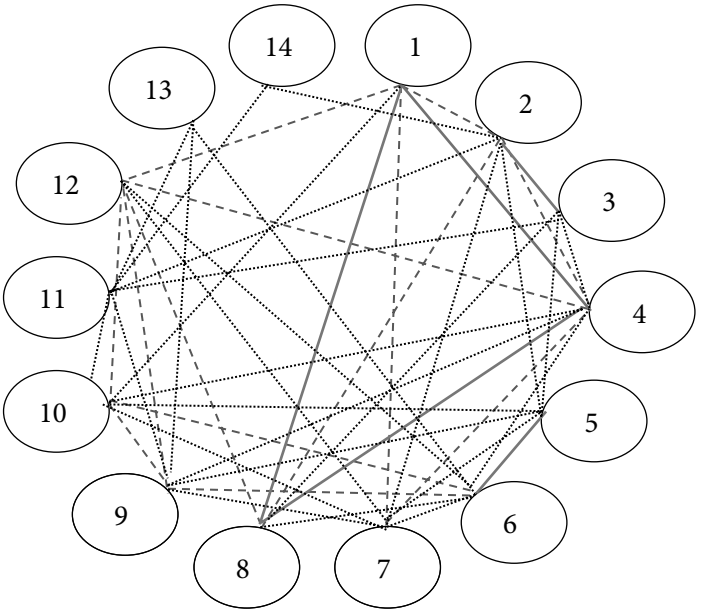
At the second testing, the indicators for physical development are stable. The most variating ones are: 2 (Weight) with value V=22,04%, and 3 (BMI), V=17,85%. At 1 (Height), V=5,90%, and 4 (Stretch), V=7,49% - least variable. The group is relatively homogenous at indicators 5 (Running 20m), V=9,87, 6 (Long jump), V=9,36%, indicator 7 (Vertical jump), 10,54%. The highest variation marks 8 (Throwing of a thick ball) - V=28,11%. This means that the group is non-homogenous at this indicator. For the tested indicators for technical preparedness, the group is very much homogenous at "Defensive movement T" (indicator 11), (V=4,23%), "Dribble between stands" (indicator 12), (V=2,61%), and "Shooting in motion – Time" (indicator 13), (3,65%). At "Shooting in motion – coefficient" (indicator 14), the sample is non-homogenous, (V=26,68%).

One of the essential mathematical approaches in analyzing existing interlinkages between the physical preparedness indicators of the tested group of adolescent women basketball players is the correlation-structural analysis.

With its help, on the one hand, the degree of dependence between the various indicators is determined and, on the other hand, it reveals complex links and relationships between individual parameters of the physical readiness of the population examined. The basis for analyzing of the observed values for the basketball players are the correlation coefficients with a high level of significance: $\alpha \leq .05$ and $r \geq .30$. According to the theory of the mathematical statistics (Brogli, 1986), (Gigova, 1999), the verbal inter-

pretation of the correlation coefficients should be prepared as follows: at r = 0.3-0.5 – "moderate interdependence"; at r = 0.5-0.7 – "significant interdependence"; at r = 0.7-0.9 – "high interdependence".

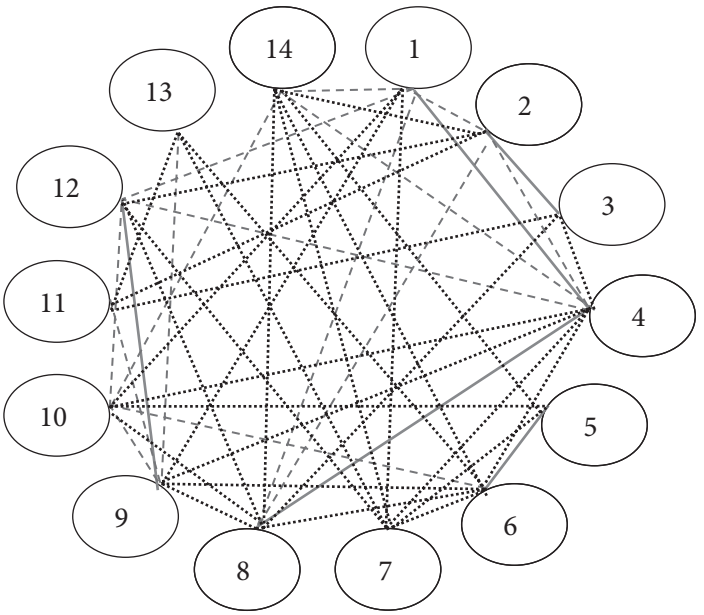
The analysis of Figure 1. reveals that there are 45 reliable correlations between the indicators from the first testing of the basketball players. The highest number of interlinkages with the others (with 8 each) show the indicators 2, 4, 6, 7, 9 and 10 ("Weight", "Stretch", "Long jump from standing position", "Vertical jump", "Sit-ups" and "Shuttles 112 m."). High interdependence is noticed for 5 indicators, significant interdependence for 13 indicators, and moderate are 27 of the interdependencies between the indicators tested.



at r=0,3-0,5 – "moderate interdependence" ·····;
at r=0,5-0,7 – "significant interdependence" - - - - - - - - - - - -;
at r=0,7-0,9 – "high interdependence" ——————.

Figure 1. *Correlation-structural model of the sports preparedness of the basketball players during the first testing*

Figure 2 presents the correlation-structural model of the sports preparedness of the girls under 12 y.o. at the second testing. There are 47 correlations between the indicators found. The highest number of interdependencies (10) has indicator 4 ("Stretch"). Strong are the interdependencies between height and stretch, weight and body mass index, stretch and throwing a thick ball forward, long jump and vertical jump, and between sit-ups and the dribbling between stands (r_{1-4} = .900, r_{2-3} = .869, r_{4-8} = .846, r_{5-6} = -.795, r_{9-12} = .748). High interdependence is observed for 5 indicators, significant – for 14 indicators, and moderate interdependencies are 28 for the studied indicators.



at r=0,3-0,5 – "moderate interdependence" ·····;
at r=0,5-0,7 – "significant interdependence" - - - - - - - - - - - -;
at r=0,7-0,9 – "high interdependence" ——————.

Figure 2. *Correlation-structural model of the sports preparedness of the basketball players during the second testing*

DISCUSSION AND CONCLUSION

The analysis of the two tests shows that basketball players have achieved better results in the second testing. The applied training program has had a positive effect on the sports preparedness of basketball players. The most significant improvements are observed for "long jump from standing position" (indicator 6), which is a prerequisite for the better performance of the technical skills and moves (shooting with a jump, shooting in motion, defensive movement, misleading movements). The better results at "throwing of a thick ball forward" (indicator 8), show the positive effect of the upper limbs muscles and the muscles of the shoulder girdle. This will help the young basketball players to obtain a ball jumped off the basket, during offense and defense, to improve their techniques for catching and throwing the ball in motion, as well as for resistance during the defense against a dribbling player. The improved capabilities in indicator 9 "sit-ups" have positive impact on performing shooting with a jump and misleading movements. The linear speed – "running 20m" (indicator 5) supports the faster movement of the basketball players on the field and the higher number of counter-attacks and quick breakthroughs.

The achieved result at the second testing for "shooting in motion – coefficient" (indicator 14) is a prerequisite for a better and successful play of the basketball players, which is very important for the basketball game.

At the correlation analysis of the first testing, 45 correlations have been created between the performance indicators. Of which, 27 are with moderate interdependence, 13 with significant interdependence, 4 with high interdependence, and 1 with very high interdependence. For the second testing, 47 interlinkages are formed between the performance indicators for the sports preparedness of the young basketball players. 27 are with moderate interdependence, 14 – with significant interdependence, and with high interdependence – 5. Overall, most of the interconnections are with moderate interdependence which shows that the indicators have moderate influence over the sports preparedness of basketball players - girls under 12 y.o.

The training program used may be updated and revised with increasing the volume of the technical training, the technical skills and movements performed at higher speed in the two phases of the game – offense and defense.

REFERENCES

Aladzhov, K. (1992). *Fizicheska podgotovka na sportista*, Sofia.

Brogli, Ya. (1986). *Statisticheski metodi v sporta*, M&F, Sofia.

Gigova, V. (1999). *Statisticheska obrabotka i analiz na dannite sas S.P.S.S.,* Sofia.

Karabiberov, Yu., Bonov, P. (2000). *Atleticheskata podgotovka v basketbola*, NSA-IPB, Sofia.

Petkov, S., Toteva, M., Maznev, I. (2002). *Prakticheski uprazhnenia po sportna meditsina, I chast*, Sofia.

Slanchev, P. (1992). *Sportna meditsina: Uchebnik za studenti ot NSA*, Meditsina i fizkultura, Sofia.

Tsankov, Ts. (2005). *Skorostno-silova podgotovka na podrastvashti basketbolistki*, NSA PRES, Sofia.

Tsankov, Ts. (2020). *Mnogogodishna podgotovka na basketbolistki*, Nays An EOOD, Sofia.

Tsankov, Ts. & Tsankova, J. (2013). Research on the competitive performance of the Bulgarian National team of under 16 female players in the European Championship, Division B in 2012, *SPORT MONT*, XI/37,38,39/ pp. 534-541

Tsankova-Kaloyanova, M. – Korelatsionna struktura na fizicheskoto razvitie, spetsialnata fizicheska i spetsifichnata tehniko-takticheska podgotvenost pri 16 godishni basketbolistki. *Sport i nauka*, izv. br.1, str. 167-173.

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ANALYSIS AND ASSESSMENT OF THE SPORTS PREPAREDNESS OF FEMALE BASKETBALL PLAYERS UP TO 16 YEARS OF AGE

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ABSTRACT
Sports preparedness is one of the most important aspects of the multi-year sports training, and it is the base for building sports mastery in players. Reaching the optimal sports condition, pending the realistic abilities and qualities of each one of the women basketballers, to a great extent depends on the good and correct planning and selection of specific training methods characteristic for the certain age group. The purpose of our study is to establish the level of sports preparedness before the final tournament of the national women's championship of basketball players up to 16 years old from the NSA representative basketball team. That momentary status has been revealed through analysis and assessment of their physical development, physical and technical-tactical preparedness before the official championship match. The following research methods have been used: thorough review of the specialized literature and sports-pedagogical testing in 14 indicators (3 anthropometric, 5 for physical preparedness and 5 for technical-tactical preparedness). The results from the conducted tests have been processed mathematically and statistically via: comparative analysis, variation analysis and sigma method of assessment. Based on the gathered results, we can conclude that there is some lagging behind in the speed of movement without the ball, in performing of the technique of dribbling combined with running, and in the strength of the abdominal muscles as compared to the best-performing basketball playing women in the same age group. The applied training programs should be adequate to the objective patterns of the adaptation process, as well as consistent with the sports calendar of the basketball players of the respective age group. The assessment of the momentary status of the sports preparedness of female basketball players under 16 is a proof for the adequate periodization of their training, and a prerequisite for high sports results in their competition career.

Keywords: *basketball, technical-tactical preparedness, evaluation, control.*

INTRODUCTION

The planning, programming and execution of a successful and winning training process is the leading paradigm for every future and wishing a successful realization training coach. Knowledge of the current updated information about previous successful outcomes achieved by studied winning teams at a specific age is a good prerequisite for a proper, successful and tailor-made changing environment corresponding to the modern conditions, and is also a prerequisite for a new set-up for new and unexplored realities and situations in which coaches and athletes are placed in new times. This would enrich and update the current theory of sports training and sports preparedness. Control of this preparedness and feedback between the object and the subject in this process is a prerequisite for its successful modification and scientifically sound re-programming in future new planning and forecasting. The concept of control refers only to the assessment of the momentary condition of athletes' preparedness (Brogli, 2012). In a number of scientific developments, control is understood precisely to measure the current status of athletes trained by the coaches and they propose tables to assess this condition, and define it as a prerequisite for more efficient building of the training program activity and for achieving successful future competition results and implementation.

Sport training is an extremely effective "tool" for an active, pedagogical, targeted impact on the sports player for development, improvement, and the manifestation of his or her motor and intellectual capabilities.

Modern sports theory more strongly suggests that achieving high and stable sports results can only be achieved on the basis of a well-built and structured multi-annual sports training (Tsankov, 2020).

The important structural changes made in the content of the basketball game generate objective patterns to be taken into account in the course of its development and improvement. One of the characteristic features of this development is the continuous activation of the game and the increasing demands for the players' functional capabilities (Zhelyazkov, 1968).

The studying of motor actions that basketball players use shows that the motor skills that are needed

are not shown separately, but always simultaneously and in combination.

The level of development of the physical characteristics of basketball players has an impact on their sports preparedness. On this issue, studies were carried out by (Tsankov, Tsankova, 2013); (Tsankova-Kaloyanova, 2018).

The main purpose of training preparation for adolescent boys and girls is to complete the general design of the technical-tactical and playing mastership with the age-appropriate methods and tools (Varbanov, 2015).

Aim and objectives of the study

The aim of this study is to establish the level of sports preparedness before the final tournament from the national championship for the women basketball players under 16 years of age from the representative basketball team of the NSA.

METHODS

The current study was conducted in April 2020. The study was conducted with the consent of the athletes and their parents, who have filled in declarations of consent for participation in the process of this study.

The subject of study is the sports preparedness of adolescent women basketball players.

The object of study are the main performance indicators of the momentary physical condition and development, the physical and technical-tactical preparedness in basketball.

The tested sample group are basketball players from the women's representative team of NSA, under 16 y.o.

In order to fulfil the set goals and tasks of the current study, the following methods of research were selected and applied:

1. Studying and analysis of the specialized literature,
2. Anthropometry – to uncover the status of the main anthropometric indices. Measurements were carried out with standard instruments and by standard methodologies (Slanchev, 1998).
3. Sports-pedagogical testing – to determine the current level of sports preparedness of the tested basketball players. For this purpose, 14 tests were selected and used, which can be grouped as follows:

- for physical development – 3 indicators (1st to 3rd);
- for physical preparedness – 5 indicators (4th to 8th);
- for technical preparedness – 6 indicators (9th to 14th);

The achieved results were mathematically-statistically processed through applying: variation analysis, comparative analysis and the sigma method of assessment.

The scores of the studied team of adolescent women under 16 y.o. from the NSA team, as well as the scores of the best basketball players of this age group, are according to a normative table from 2016 by (Tsankova-Kaloyanova, 2016).

RESULTS

The results from the variation analysis of the indicators for physical development, physical and technical-tactical preparedness of the basketball players – women under 16 y.o. of the NSA team are presented in (Table 1).

Table 1. *Variation analysis of the sports preparedness of women basketball players under 16 years of age*

№	Indicators	X	S	V	min	max	As	Ex
1.	Height	168.36	5.76	3.42	160	178	0.37	-0.93
2.	Weight	62.93	10.68	19.97	48	80	0.29	-1.11
3.	Stretch	169.5	9.89	5.83	153	183	-0.21	-1.42
4.	Sprint 20 m	3.76	0.25	6.65	3.25	4.12	-0.30	0.03
5.	Running between stands	23.81	1.39	5.84	25.87	21.48	-0.44	-0.91
6.	Running "Shuttle"	46.81	2.01	4.29	42.37	49.36	-0.72	0.27
7.	Vertical jump	31.17	3.07	9.85	27.69	38.57	1.21	1.16
8.	Sit-ups	17.93	4.03	22.48	15	31	2.96	9.84
9.	Defensive movement	10.32	1.02	9.88	8.66	11.90	-0.05	-0.99
10.	Dribble between stands	25.10	1.72	6.85	27.48	21.96	-0.59	-0.34
11.	Dribble index	1.29	0.88	68.21	3.56	-0.6	1.52	2.20
12.	Shooting in motion-t	36.73	2.68	7.30	29.43	39.98	-1.49	3.46
13.	Shooting in motion-coeff.	7.61	1.52	19.97	5.80	9.86	0.33	-1.43
14.	Shooting with ball-thrower, % successful	52.62	8.69	16.51	40.00	63.33	-0.36	-1.39

Figure 1 shows the variation analysis of the physical development of the basketball players girls under 16 y.o. The group is homogenous in terms of indicator 2 "Weight", V=19,97.

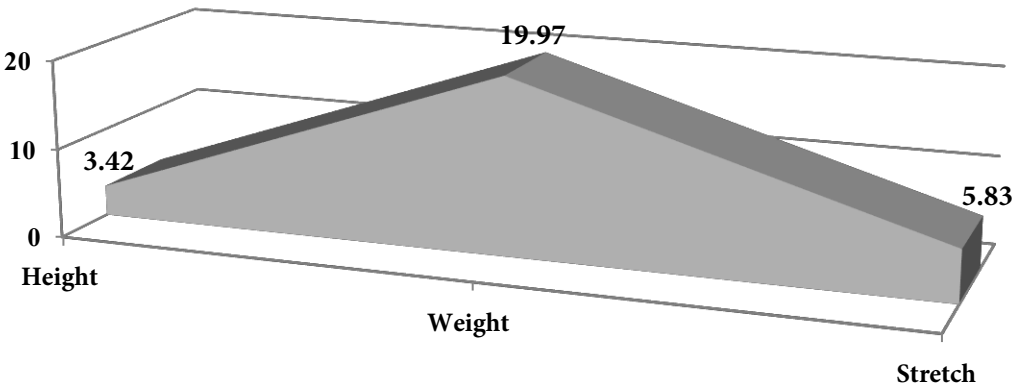

Figure 1. *Variation analysis of the physical development of women basketball players under 16 y.o.*

The analysis of Figure 2. shows that the indicators for physical preparedness for the young basketball players are stable. The most-variable indicator is 8 "Sit-ups" – V=22.48, which reveals that the players are relatively homogenous in terms of the strength of their stomach muscles.

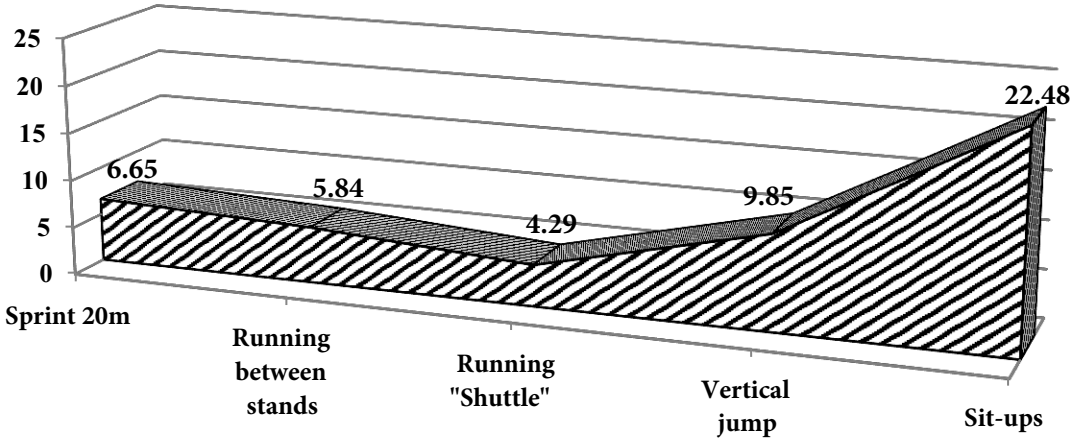

Figure 2. *Variation analysis of the physical preparedness of women basketball players under 16 y.o.*

Figure 3 represents the variation analysis of the indicators which are related to the technical-tactical preparedness of the studied group of basketball players. From the achieved results we concluded that the group is relatively homogenous at indicators 13 "Shooting in motion – coefficient", V=19,97%, and indicator 14 "Shooting with ball-thrower, % successful", V=16,51%. The sample group is highly non-homogenous at indicator 11 "Dribble index", V=68,21. This shows that this characteristic is not stable among the studied players. The team is non-homogenous when it comes to technical skills for movement along the playfield, while dribbling the ball, at high speed.

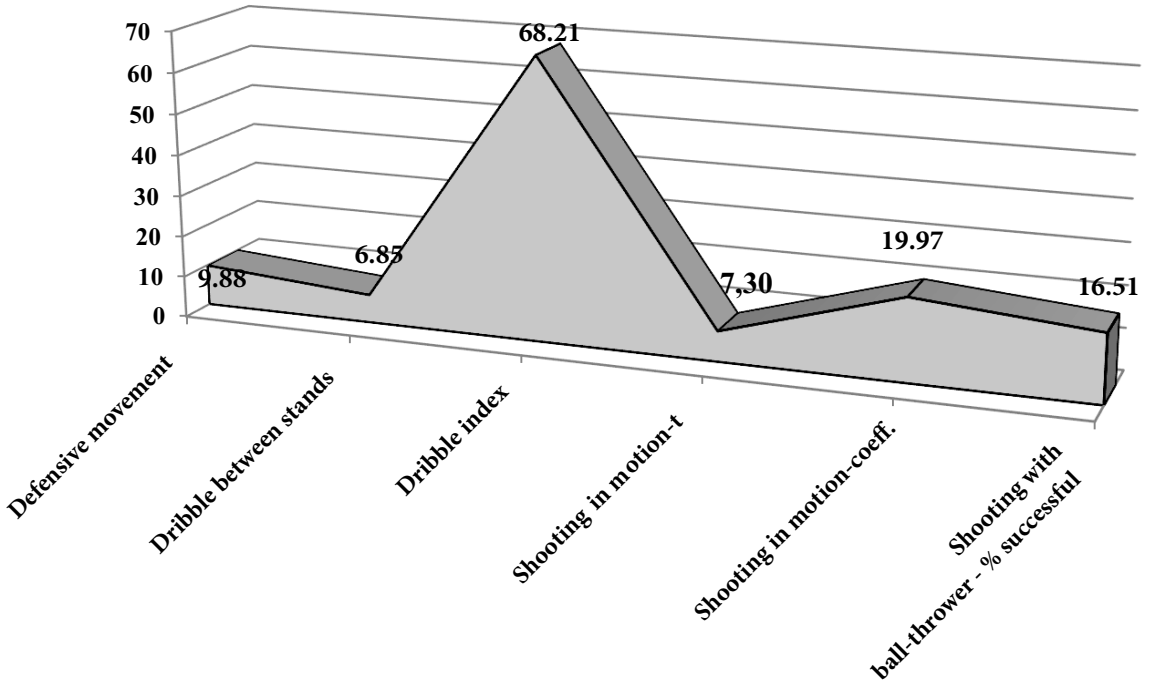

Figure 3. *Variation analysis of the technical-tactical preparedness of women basketball players under 16 y.o.*

In order to achieve the goal and tasks of this study, we have carried out assessment of the performance of the basketball players - girls under 16 y.o. of NSA, as compared to the results of the best basketball players from the National Team women cadets, per the indicators for sports efficiency. The scores of the team in (P%) are presented visually in Figure 4. We can observe that for some of the studied indicators, the scores T are lower than the average scores for this age group among elite basketball players. This means that the NSA basketball players - girls experience some issues with the performance of their sports preparedness, based on the studied performance indicators.

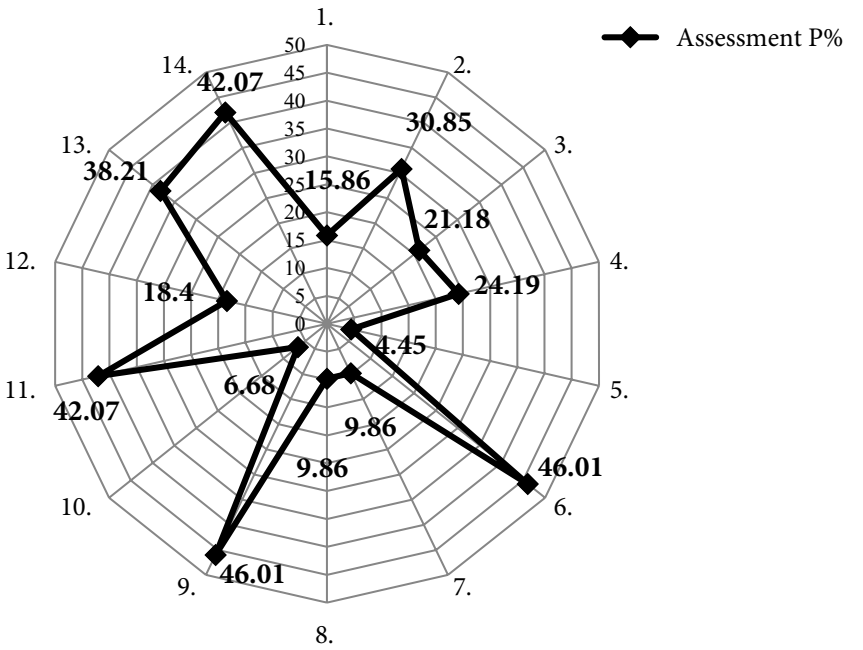

Figure 4. *Assessment of the sports preparedness of women basketball players under 16 y.o.*

DISCUSSION AND CONCLUSION

Based on the analyses and the processed results we can conclude that we notice some lagging behind in part of the game performance indicators of the studied team in comparison with the best basketball players of the same age group. For none of the measured indicators has the studied team achieved a score above the average of the elite players. Only for 4 of the indicators (indicators 6 "Running "Shuttles"; indicator 9 "Defensive movement"; indicator 11 "Dribble index"; indicator 14 "Shooting with ball-thrower, % successful") the results are close to the average ones of the best players and their value is up to P=46,01%. For 5 of the indicators (indicator 1 "Height"; indicator 5 "Running between stands"; indicator 7 "Vertical jump"; indicator 8 "Sit-ups"; indicator 10 "Dribble between stands"), we have poor scores. Among the studied basketball players, we can observe lagging behind in their capabilities and their current skills for quick movement along the playfield without a ball. The same applies for their ability to move quickly while dribbling the ball. Low are the scores for the indicators showing the explosive capabilities of the lower limbs and the strength of the abdominal muscles.

Taking into account the results obtained from the evaluation of sports preparedness of the examined basketball players, the following adjustments must be made in the construction of their future training program It should aim at increasing the volume of training impacts that would contribute to increasing the players' speed capabilities. In individual training sessions, specific basketball methods should be included to improve the technical ability to dribble the ball while actively counteracting the opposing player, in an environment close to a real match game.

Considering the findings made about the momentary condition before future important competitions will be a prerequisite for better competitive performance.

REFERENCES

Brogli, Ya. (2012). *Vavedenie v teoriyata i praktikata na kontrola varhu faktorite na sportnoto postizhenie,* BPS OOD, Sofia.

Zhelyazkov, Tsv. (1968). *Teoria i metodika na sportnata trenirovka*. M&F, Sofia.

Slanchev, P. (1992). *Sportna meditsina: Uchebnik za studenti ot NSA*, Meditsina i fizkultura, Sofia.

Tsankov, Ts. (2020). *Mnogogodishna podgotovka na basketbolistki*, Nays An EOOD, Sofia.

Tsankov, Ts. & Tsankova, J. (2013). Research on the competitive performance of the Bulgarian National team of under 16 female players in the European Championship, Division B in 2012, SPORT MONT, XI/37,38,39/ pp. 534-541

Tsankova-Kaloyanova, M. – Korelatsionna struktura na fizicheskoto razvitie, spetsialnata fizicheska i spetsifichnata tehniko-takticheska podgotvenost pri 16 godishni basketbolistki. *Sport i nauka*, izv. br.1, str. 167-173.

Tsankova-Kaloyanova, M. (2016). Vliyanie na sportnata podgotvenost varhu sastezatelnata realizatsia pri podrastvashti basketbolistki, Veliko Tarnovo.

Varbanov, I. (2015). *Savremenni tendentsii v handbala*, NSA Pres, Sofia.

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STRENGTH AND CONDITIONING PROFILE OF THE MOTIONS IN VOLLEYBALL

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ABSTRACT
Most of the scientific reports about volleyball are focused on the technical aspect of the game and a very small amount of them are about time motion analysis. In this regard to the fore comes the necessity of the quantification of the time motion profile of the volleyball game. These analyses are important to the objectification of strength and conditioning. The aim of this research is to study the different motions of 16-17 years old female volleyball players. The main task of this report is to define basic motions that characterize the volleyball game. The second task of the research is to quantify this motion in a real game situation. The methods that are used for this research are video and statistical analysis. After thoroughly researching the reports on this topic we design a model for time motion characteristics that are important for strength and conditioning. It was based on and complied with all of the previously developed models with some modifications. The data were collected through video records of the 5 matches during the championship of the mentioned age group. Experience statistician derived the absolute values of all the motions. Based on the number of players that consist in one team it was calculated mean, maximal, and minimal values of all of the motions. Results: In total, one volleyball game at this age consisted of 83 rallies of different lengths. In these rallies one player makes 75 jumps with a different approach, 56 starts, and sprints at different distances. The most common jump is the standing jump followed by the jump after two steps. The most common movement in a game is the 3 m sprint. More than half of the rallies finished up to 10 seconds. Defending motions of the players are twice more than the attacking ones. Conclusion: On the basis of the received results in motion characteristics to the fore comes the conclusion that speed and power endurance are important factors in the game for this age group.

Keywords: *games, female, jumps, sprints, rally time*

INTRODUCTION

Success in volleyball depends on the athlete's ability to jump higher, quickly, and explosively while performing basic motions such as setting, blocking, tips, spiking jumps, serving (Vilamitjana et al., 2008). Before determining how to improve these abilities, it is important to place considerable emphasis on defining basic motions that characterize the volleyball game and quantify them.

Volleyball uses several complex motions during matches and training sessions. Being able to attack and defend requires the high performance of a jump. Thus, jumping (especially the spiking jump) is considered an important basic technique in volleyball (Drikos et al., 2009). Eventually, jumping performance is determining factor in volleyball games (Ziv & Lidor, 2010). The explosive strength and reactive strength are the strength most used during volleyball matches (Marques, 2019). According to Sheppard et al. (2008) strength and power undoubtedly contribute to jump performance. For optimal performance, jump height is an important parameter that demonstrates a good index of explosive strength in volleyball players (Centeno-Prada et al., 2015).

Also, many studies have shown moderate to strong relationships between jump performance and strength measures in volleyball players (Sheppard et al., 2007). Even though volleyball is classified as a technical team sport belonging to a group of strength and speed sports (Tillman et al., 2004), it is important to set as a goal the improvement of the strength of players. In such cases, it is required to determine the number of basic motions of the volleyball game because this helps in the objectification of the strength and conditioning. Jumping characterize one of the most used motions of a volleyball game.

Passing is another major motion, which characterized the volleyball game. It is considered to be very important because it determines the quality of a team's attack (Fortes et al., 2020).

Rallies are another part in volleyball that we should take into consideration. Knowing the number of rallies, and their length during volleyball matches in order to prepare players in line with the physiological and metabolic requirements of the game and to design the training programs (Sheppard & Newton, 2012).

While researches had mainly focused on the technical and tactical parts of the volleyball game and factors affecting performance in men's volleyball. There are also studies that investigated motion analysis. Coaches seek ways to enhance the performances of their teams in order to perform better during championship matches (Hughes & Franks, 2008; Lago-Ballesteros & Lago-Peñas, 2010). Thus, monitoring performance in a quantitative way is an important part of a coaches' strength and conditioning training plans. As more of the authors stated strength is the key performance indicator for elite volleyball. That makes this parameter development an important indicator for successful progress from junior to senior representation in volleyball.-

In order to reveal strength and condition profile of young volleyball players, we used quantitative motion data (motion analysis). This can help to design the appropriate program for increasing this physical quality.

Consequently, the ***aim*** of the current study was to study different motions in young female volleyball players.

The tasks of the research are:

1) First of all, to study different motions in a volleyball game in young 16-17 years old female volleyball players;
2) Second to quantify these motions in an official game.

METHODS

The study sample was comprised of a total of 5 matches and 20 sets, carried out by 10 teams participating in the Albanian Volleyball Championship (2021-2022) organized by the Albanian Volleyball Federation. We used video records of the games and analyzed the total number of movements in every possible direction. The variables that we studied are based on previous research and they were transformed through our perspective for the conditioning in volleyball. The chosen categories were: standing jump, jump from one leg, dive jump, jump after one step, jump after two steps, jump after three steps, jump after more than three steps, passes, tips, starts and running until 3 meters, starts and running between 3 and 6 meters, starts and running more than 6 meters, number of attacks, number of defenses, total rallies, number of rallies length less than 10 seconds, number of rallies length less than 20 seconds, number of rallies length more than 20 seconds and average rally time.

Participants

Sixty volleyball players in the age group 16-17 years took part in the research. Their training experience is between 2-6 years and at the moment of the research, they trained between 3 and 6 times per week. All participants were physically healthy and reported no injuries during the time of the study. Parental consent was obtained for all participants of the study.

Data capture and processing

Both teams in the 5 matches and 20 sets were analyzed from video records. Video camera SONY HDR-PJ670 were positioned in a way that all the court could be monitored thoroughly and continuously, nearly 6-8 meters above the ground level at the middle court and 6-8 meters behind the end line. All variables of the study were analyzed from a quantitative point of view.

Variables and definitions

Rally is defined in our study as the time from the moment the serving player first touched the ball until the exact moment when the last player contacted the ball before the referee whistled to stop playing as in other reports (Sanchez-Moreno et al., 2015).

Statistical analysis

Descriptive analysis of the variables was performed to discover the mean (SD), maximum, and minimum of each studied variable. All of the statistical analyses were done with a level of significance set at $p \leq .05$. All statistical analyses were conducted using Microsoft Excel.

RESULTS

The table below shows the mean (SD), minimum and maximum of 7 types of jumps in volleyball. The mean number of standing jumps per player is 8.0 ± 6.5 jumps according to the analysis of five matches. The minimum of standing jumps is 2.7 jumps and the maximum is 25.5 jumps. Jump with one leg has a mean value of 1.4 ± 2.9 jumps, minimum of 0 jumps, and a maximum of 9.2 jumps. The mean of dive jumps is 5.1 ± 2.7 jumps per player while the minimum is 2.5 jumps and the maximum is 9.5 jumps. Jump after one step is presented with the mean of 5.7 ± 2.5 jumps per player, maximum of 10.2 jumps, and a minimum of 2.3 jumps. The mean of the jump after two steps is 6.3 ± 6.0 jumps per player with a minimum of 2.2 jumps and a max-

imum of 18.7 jumps. Jump after three steps have a mean of 2.5 ± 3.2 jumps per player and a maximum of 10.5 jumps, minimum of 0 jumps. The mean of the jump after more than three steps is 1.8 ± 2.7 per player with a minimum of 0 steps and a maximum of 8.7 steps

Table 1. *The mean (SD), minimum and maximum of standing jump, jump from one leg, dive jump, jump after one step, jump after two steps, jump after three steps and jump after more than three steps.*

Type of motion⇩	Mean (jumps)	Std. Deviation	Minimum	Maximum
Standing jump	8.0	6.5	2.7	25.5
Jump from one leg	1.4	2.9	0	9.2
Dive jump	5.1	2.7	2.5	9.5
Jump after one step	5.7	2.5	2.3	10.2
Jump after two steps	6.3	6.0	2.2	18.7
Jump after three steps	2.5	3.2	0	10.5
Jump after more than three steps	1.8	2.7	0	8.7

Table 2 indicates the mean (SD), maximum and minimum of passes, tips, starts and running until 3 meters, starts and running between 3 and 6 meters, starts and running more than 6 meters, number of attacks, and number of defenses. The mean of passes is 26.0 ± 8.1 per player with me a minimum of 14.0 passes and a maximum of 42.8 passes. Tips are presented with a mean of 8.6 ± 3.9 per player, a minimum of 3.3 tips, and a maximum of 14.8 tips. Starting and running until 3 meters has a mean of 32.8 ± 14.7 per player maximum of 61.8 and a minimum of 11.3. The mean of start and running between 3 and 6 meters is 20.0 ± 7.9 per player with a minimum value of 5.3 and a maximum of 31.5. Starts and running more than 6 meters show the mean of 3.0 ± 1.6, a maximum of 6.8, and a minimum of 1.7. The number of attacks per team has a mean of 86.1± 26.0 while the number of defenses has a mean count of 163.0 ± 50.6.

Table 2. *The mean (SD), minimum and maximum number of passes, tips, starts and running until 3 meters, starts and running between 3 and 6 meters, starts and running more than 6 meters, number of attacks, and number of defenses.*

Type of motion⇩	Mean (count)	Std. Deviation	Minimum	Maximum
Passes	26.0	8.1	14.0	42.8
Tips	8.6	3.9	3.3	14.8
Starts and runs until 3 meters	32.8	14.7	11.3	61.8
Starts and runs between 3 and 6 meters	20.0	7.9	5.3	31.5
Starts and runs more than 6 meters	3.0	1.6	1.7	6.8
Number of attacks	86.1	26.0	61.0	137.0
Number of defenses	163.0	50.6	92.0	235.0

In table 3 are shown the mean (SD), minimum and maximum number of rallies, number of rallies until 10 seconds, nr of rallies until 20 seconds and nr of rallies more than 20 seconds. The mean of the number of rallies is 82.9 ± 12.8 rallies while the minimum is 55.0 and the maximum is 95.0. Nr of rallies until 10 seconds are presented with me mean 50,6 ± 11.2, maximum of 65.0 and minimum of 34.0. Nr of rallies until 20 seconds has the mean of 25.6 ± 10.7, a maximum of 43.0, and a minimum of 13.0. The mean of the number of rallies more than 20 seconds is 6.8 ± 2.8 with a minimum of 2.0 and a maximum of 12.0 rallies.

Table 3. *The mean (SD), minimum and maximum number of rallies, number of rallies until 10 seconds, nr of rallies until 20 seconds, nr of rallies more than 20 seconds.*

Statistical data ⇨	Mean	Std. Deviation	Minimum	Maximum
Total rallies number	82.9	12.8	55.0	95.0
Nr of rallies until 10 seconds	50.6	11.2	34.0	65.0
Nr of rallies until 20 seconds	25.6	10.7	13.0	43.0
Nr of rallies more than 20 seconds	6.8	2.8	2.0	12.0

DISCUSSION

This paper presents the basic motions of the volleyball game and quantification of the time motion profile of the volleyball players. In our study the basic motion that characterized the volleyball game consists of 7 types of jumps (standing jump, jump from one leg, dive jump, jump after one step, jump after two steps, jump after three steps and jump after more than three steps), passes, tips, starts and running in different distances (start and running until 3 m, starts and running between 3 and 6 m, stars and running more than 6 m), number of defenses, number of attacks, nr of rallies (nr of rallies until 10 sec, nr of rallies until 20 sec and nr of rallies more than 20 sec). The result of our study showed that the player makes 75 jumps with a different approach, 56 starts and sprints at different distances in one volleyball game with 83 rallies with different lengths. The most common jump is the standing jump followed by the jump after two steps. 3 meters sprint is the most common motion in a volleyball game. More than the halve of the rallies played during matches had a duration of less than 10 seconds. Analyzing the data, the results of our study concluded that the players' defending movements were twice more often than the attacking ones.

Training volume has been associated with the number of jumps in volleyball. Consequently, jumping performance is an important issue in developing training programs and can help develop age-appropriate training programs. According to Lima et al., (2019) knowing the number of jumps in games could contribute to the evaluation of individualized training loads and injury prevention. The study of Skazalski et al., (2018) counted 3637 jumps performed during practice and match play using the vert device. This high volume of jumps shows the importance of this skill in volleyball. That is the reason to study and analyzed this locomotion from the quantitative perspectives.

Our result showed that the most common jump is the standing jump (performed during block move). Similar to our findings was the study of Pisa et al. (2022) where block and attack movements have a higher jump load during matches. Moreover, Piatti et al. (2022) reported that player type of jumps gives coaches appropriate insight into the physical exertion and technical requirement of each in-game role. Top-level volleyball players performed jumping skills on average 40.000 times a year in different positions, the middle blocker consistently presented the greatest jump loads during the season (Martinez. D. B, 2017). On the contrary, the smallest jump loads were observed in the setter. In contrast to our research and Piatti et al. (2022) research, in the study of Skazalski et al. (2018) setting jump was the greatest volume of jumps (121 jumps per training session) in professional volleyball. Whereas in our study number of passes were 155 passes per training session, but must be mentioned that most of the passes did not involve jumping during the performance. It is preferable to perform jump sets because it increases the speed of play, options of obtaining points, and limit the defense (Castro et al., 2011).

The results of the study reported that the player makes 75 jumps with a different approach in one match. That number is similar to the study of (Mori et al., 2022), where the average number of jumps was 79.6 times per player in one volleyball game. Regarding the rally length, the results of our study show that more than half of the rallies finished up to 10 seconds whereas the number of rallies of more than 20 seconds has the lowest number of occurrences in the game. According to Sánchez-Moreno et al. (2017) rallies less than 10 seconds emerged as a critical incident of the game (being closer to the final action) while rallies longer than 10 seconds seemed to be less decisive by balancing the chances of success between both teams because it loses the initial advantages of being the first team to attack.

The attack is considered a fundamental parameter in winning or losing the game. In the study of Sopa & Szabo (2020) the number of attacks for the first game was 112 attacks and 72 was the number of defenses while in the second match the number was 72 attacks and 67 defenses. Contrary to our study where the number of defenses (163±50.6) were higher compared to number of attacks (86.1±26). Volleyball for women presents different numbers and patterns of attack and defenses compared to volleyball for men. According to Costa, G et al., (2012), there are three variables, that showed differences between males and females in volleyball: attack tempo, attack type and serve type. Men in volleyball apply more powerful jump serves and quicker attack tempo compares to women (Palao et al., 2009).

Results of Hazir-Aytan et al. (2019) study revealed that the mean rally length was 6.88±5.94s in elite women's volleyball while Sanchez-Moreno et al. (2019) reported in their study that rally length had the mean of 4.99±4.35s on elite man' volleyball. Whereas Tsakiri et al. (2021) showed that the mean values for rally length was 5.98 seconds for men and 4.98 seconds for woman. In 2018-2019 volley nations league (VNL) indoor volleyball tournament recorded 5.65 s active time for men and 7.13 seconds for women (F.I.V.B., 2019). In these researches, rally lengths were mostly until 10 seconds, according to Hazir-Aytan et al. (2019) these rally lengths are considered medium duration (8-11 sec). These findings supported the results of our study which reports that the most common rallies were rallies until 10 seconds. According to Tsakiri et al., 2021 higher performance of defensive volleyball skills contributes to the higher rally length in volleyball.

Limitation of the study

As for the limitation of the study, despite the fact that the study was limited to 10 teams and 5 matches, the methods used could be better. In the future, these limitations should be considered as well as other limitations, which is the participants from the profession category.

Practical implementation

The findings of the study might be used to aid the professionals and coaches working with youth volleyball players in preparing the appropriate conditioning programs for the different requirements of the matches and training sessions. This information may also be useful to manage the substitutions, because knowing the physical and psychological characteristics of their players, they can take more assertive decisions, putting the players in play with the best profile during each particular phase of the game.

CONCLUSION

The conclusion of our study presented that speed and power endurance are important factors in the game for this age group based on the received results. The result of our research highlights the importance of power, speed and strength in volleyball training. Those physical parameters are vital for winning because they are associated with success. This study arouses the interest of strength and conditioning coaches for the 16-17 age group. In order to know how much the load coach should use throughout the preparatory stages, it is important to know the load of each locomotion during the game. Thus, monitoring the players' jump loads and performance by using different methods that provides data which can be used to plan individual player activity, season calendar, raster composition. Moreover, it helps to reduce over-training and the occurrence of injuries.

REFERENCES

Costa, G., Afonso, J., Brant, E., & Mesquita, I. (2012). Differences in game patterns between male and female youth volleyball, *Kinesiology*, *44*(1): 60-66;

Castro, J., Souza, A., & Mesquita, I. (2011). Attack efficacy in volleyball: elite male teams, *Percept. Mot. Skill,* 113: 395–408. doi: 10.2466/05.25.pms.113.5.395-408;

Drikos, S., Kountouris, P., Laios, A., & Laios, Y. (2009). Correlates of team performance in volleyball, *International Journal of Performance Analysis in Sport*, 9(2), 149–156;

F.I.V.B. (2019). Picture of the game. 2019 Volleyball Nations League;

Fortes, L. S., Freitas-Júnior, C. G., Paes, P. P., Vieira, L. F., Nascimento-Júnior, J. R., Lima-Júnior, D. R. A. A., & Ferreira, M. E. (2020). Effect of an eight-week imagery training programme on passing decision-making of young volleyball players, *International Journal of Sport and Exercise Psychology*, *18*(1): 120-128;

Hazir-Aytan, S., Akarcesme, C. & Akif-Barik, M. (2019). Rally length and rest time in women's volleyball, *International journal of applied exercise physiology*. Vol. 8(3.1);

Hughes, M., & Franks, I. (2008). *The essentials of performance analysis: an introduction,* London: Routledge;

Lago-Ballesteros, J., & Lago-Peñas, C. (2010). Perfor-

mance in team sports: Identifying the keys to success in soccer, *Journal of Human Kinetics*, 25: 85-91;

Lima, R. F., Palao, J. M., & Clemente, F. M. (2019). Jump Performance during Official Matches in Elite Volleyball Players: A Pilot Study, *Journal of Human Kinetics*, 67:259-269;

Mantiez, D.B. (2017). Consideration for power and capacity in volleyball vertical jump performance, *Strength and conditional journal*, 39(4): 36-48 DOI: 10.1519/SSC.0000000000000297;

Marques Jr., N. (2019). Specific periodization for the volleyball: a training organization with ball and of the physical training, In: *Revista Brasileira Prescricao Fisiologia do Exercicio*, Vol. 13, Issue 81: 58–69. DOI: 10.15406/mojsm.2020.04.00086;

Mori, Y., Yamada, Y., Umezaki, S., Kida, N. & Nomura, T. (2022). A study of the number of jumps and jump height in volleyball: From a Mock game of college men players, *Advances in Physical Education*, 11: 1-10;

Palao, J., Manzanares, P., & Ortega, E. (2009). Techniques used and efficacy of volleyball skills in relation to gender, *International Journal of Performance Analysis in Sport*, 9(2): 281-293;

Piatti, M., Ambrosi, E., Dedda, G., Omeljaniuk, R. J., Turati, M., Bigoni, M., & Gaddi, D (2022). Jump performance during a season in elite volleyball players, *J Sports Med Phys Fitness*, 62: 602-8. DOI: 10.23736/S0022-4707.21.12268-6;

Pisa, M. F., Zecchin, A. M., Gomes, L. G., & Puggina, E. F. (2022). External load in male professional volleyball: A systematic review, *Baltic Journal of Health and Physical Activity*, *14*(2): 7;

Centeno-Prada, R. A., López, C., & Naranjo-Orellana, J. (2015). Jump percentile: a proposal for evaluation of high level sportsmen. *Journal of Sports Medicine and Physical Fitness*, *55*(5), 464-70;

Sanchez-Moreno J, Afonso J, Mesquita I & Urena A. (2016). Dynamics between playing activities and rest time in high-level men's volleyball. *Int J Perf Anal Sport*, 16(1): 317-31;

Sanchez-Moreno J, Marcelino R, Mesquita I & Urena A. (2015). Analysis of the rally length as a critical incident of the game in elite male volleyball. *Int J Perf Anal Sport*, 15(2):620-31.

Sánchez-Moreno, J., Mesquita, I., Afonso, J., Millán-Sánchez, A., & Ureña, A. (2017). Effect of the rally length on performance according to the final action and the playing level in high-level men's volleyball. *Revista Internacional de Ciencias del Deporte. doi: 10.5232/ricyde*, *14*(52): 136-147.

Sheppard JM, Newton RU. (2012). Long-term training adaptations in elite male volleyball players. *J Strength Cond Res*. 26(8): 2180-4;

Sheppard, J. M., Cronin, J. B., Gabbett, T. J., McGuigan, M. R., Etxebarria, N., & Newton, R. U. (2008). Relative importance of strength, power, and anthropometric measures to jump performance of elite volleyball players. *The Journal of Strength & Conditioning Research*, 22(3): 758–765.

Sheppard, JM, Cronin, J, Gabbett, TJ, McGuigan, MR, Etxebarria, N. & Newton, RU. (2007). Relative importance of strength and power qualities to jump performance in elite male volleyball players, *J Strength Cond Res* 22: 758–765;
Skazalski, C. M., Whiteley, R., Hansen, C. & Bahr, R. (2018). A valid and reliable method to measure jump-specific training and competition load in elite volleyball players. *Scandinavian Journal of Medicine & Science in Sports, 28:* 1579-1585;

Skazalski, C., Whiteley, R., & Bahr, R. (2018). High jump demands in professional volleyball—Large variability exists between players and player positions. *Scandinavian journal of medicine & science in sports*, *28*(11): 2293-2298;

Sopa, I. S., & Szabo, D. A. (2020). Comparison between Statistical Parameters of Attack and Defence in high volleyball performance (CSM Volei Alba Blaj in the CEV Champions League Final Four 2018), *Bulletin of the Transilvania University of Braşov. Series IX: Sciences of Human Kinetics*, 92-102;

Tillman, M. D., Hass, C. J., Brunt, D. (2004). *Jumping and landing techniques in elite women's volleyball. In: Journal of Sports Science and Medicine,* Vol. 3: 30–36. PMID: 24497818 PMCID: PMC3896111;

Vilamitjana, J.J.; Soler, D.; Barrial, J.M.; Del Grecco, P.; Montes, M.; Rodríguez, F. (2008). Jumping profile of elite volleyball male players by field positions during a competitive season. *Med. Sci. Sports Exerc,* 40: S383;

Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: A review of observational and experimental studies. *Scandinavian Journal of Medicine & Science in Sports*, 20(4): 556–567.

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DYNAMICS OF DEVELOPMENT OF SOME ANTHROPOMETRIC INDICATORS IN GIRLS BASKETBALL PLAYERS

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ABSTRACT
Worldwide, conducting systematic research and control of sports-competitive activities is a severe premise to a well-programmed and managed training process. An important part of control in sports is determining the level of physical development for each gender and age. The aim of the study was to determine the level of physical development in girls up to U12, U14 and U16. The survey was conducted in March - September 2021. The subject of research are the signs of physical development in girls up to U12, U14 and U16. The object of research are the main signs of physical development. 173 girls were studied, divided into three age groups. All participants are basketball players, registered in clubs in Bulgaria. Sports and pedagogical testing were conducted with the participants with the test battery, which includes 7 indicators. The applied research methods are: review study of the specialized literature and sports-pedagogical testing. Depending on the objectives of the study, the following statistical methods were applied: Descriptive statistics, One-way ANOVA and Comparative analysis by Student's t-test for independent samples. The results show that the age has a positive effect on the studied anthropometric characteristics. In the selection of girls up to U12, who practice basketball, we should make some corrections and select taller children. Girls from U14 are more overweight but are within the obesity norms for their age group. There is a selection problem in girls U16. There are no tall children, as desired in basketball, among the three groups.

Keywords: *young players; basketball; control; physical development*

INTRODUCTION

Human physical development is subjected to some general biological regularities, but physical development should not be characterized only by its ascending development. During some age periods, the physical development goes progressively, ascendingly, but irregularly. The changes at the early age periods are the most significant.

Organized basketball activities benefit not only children's physical development but also the harmonious development of basic motor qualities in different age periods. In order to establish these changes, one should regularly emphasize some form of control on the different parts of sports preparation. That is why a lot of scientific researchers apply various groups of tests (AAHPERD, 1984; Gyosheva et al., 1990; Pattison,1990; Karalejič, Jakovljevič, 1998; Tzarova, Borukova, 2012; Borukova, 2018; Asparuhov, 2020; Pino-Ortega et al., 2020).

One of the main groups of tests is the types of tests held when the body is at rest. These are the indicators of physical development: body lengths, body circumferences, and body weight. When the body is at rest, one can also measure muscles' functional state, and the condition of the nervous and cardiovascular systems. This group includes psychological tests as well (Borukova, 2022).

METHODS

The research was done in March – September 2021. The aim of this research was to establish the dynamics in the level of physical development of the girls under the age of 12, under the age of 14, and under the age of 16, influenced by organized basketball activities.

The subject of the research was the physical development of adolescent female basketball players. The object of the research was some major indicators of physical development.

The research was done among 173 female players who took part in the National Basketball Championship in the particular age group, and some of them play for the national teams for their age (U12, U14, and U16). For all subjects, we obtained signed informed consent from the parents for the testing of their children and for the presentation of the results.

The female players were subjected to sports-pedagogical testing along seven indicators for their physical development, included in a comprehensive test battery, presented in Table 1.

Table 1. *Description of the indicators of the physical development from the comprehensive test battery*

№	Indexes	Measure-ment units	Exact. of measurem.	Direction of increase
1.	*Height*	cm	1.0	+
2.	*Weight*	kg	0.5	
3.	*Body Mass Index*	kg/m²	0.01	
4.	Horizontal extension	cm	1.0	+
5.	*Vertical extension*	cm	1.0	+
6.	*Chest measurement - Pause*	cm	1.0	+
7.	*Chest measurement - respiratory difference*	cm	1.0	+

The applied research methods were: *a detailed study of the specialized literature and sports-pedagogical testing.*

Depending on the tasks of the research, we applied the following statistical methods: *variation analysis and one-factor dispersion analysis.*

RESULTS

The results from the variation analysis of the observed indicators of the physical development of the girls in the three age groups are presented in Table 2.

Table 2. *Mean values of dispersion of the indicators of the physical development of the girls*

	Indicators	N	X min	X max	X	S	As	Ex	V
U 12	*Height*	71	1.38	1.71	1.56	0.079	-0.229	-0.565	5.05
	Weight	71	18.55	67.00	45.14	10.306	0.017	0.166	22.83
	Body Mass Index	71	13.42	26.50	18.81	2.943	2.943	0.699	15.65
	Horizontal extension	71	1.35	1.72	1.55	0.083	-0.212	-0.275	5.33
	Vertical extension	71	1.79	2.22	2.02	0.103	-0.183	-0.489	5.13
	Chest measurement - Pause	71	60.00	98.00	78.23	7.689	0.277	-0.019	9.83
	Chest measurement - respiratory difference	71	2.00	11.00	6.46	1.468	0.232	1.152	22.73
U 14	*Height*	49	1.50	1.84	1.66	0.062	0.261	1.096	3.73
	Weight	49	39.30	106.20	59.62	11.398	1.449	4.562	19.12
	Body Mass Index	49	15.47	31.37	21.46	3.123	0.534	0.860	14.55
	Horizontal extension	49	1.54	1.82	1.66	0.064	0.220	0.050	3.86
	Vertical extension	49	1.97	2.42	2.14	0.082	0.783	1.805	3.84
	Chest measurement - Pause	49	76.00	110.00	86.18	6.369	1.139	2.816	7.39
	Chest measurement - respiratory difference	49	5.00	9.50	7.38	1.184	-0.284	-0.470	16.05
U 16	*Height*	53	1.57	1.84	1.68	0.068	0.361	-0.610	4.04
	Weight	53	48.80	91.00	62.82	9.129	1.100	1.105	14.53
	Body Mass Index	53	16.00	30.06	22.26	3.143	0.411	-0.125	14.12
	Horizontal extension	53	1.52	1.86	1.69	0.072	-0.011	-0.330	4.30
	Vertical extension	53	1.98	2.35	2.16	0.093	-0.021	-0.702	4.29
	Chest measurement - Pause	53	79.00	103.00	87.86	5.396	0.888	0.435	6.14
	Chest measurement - respiratory difference	53	4.00	10.00	7.52	1.259	-0.007	0.797	16.75

The results in Table 2 show that the values had a normal distribution, and the observed totalities were homogeneous or relatively homogeneous as regards the information these indicators bear. In the three age groups, there was homogeneity along four indicators: stature, horizontal and vertical stretch, and chess circumference – pause. A relative homogeneity was observed in the indicators related to weight characteristics: weight, BMI, and chess circumference difference. There were dynamics in the development in age aspect in all researched indicators. With the advancement in

age, there was a decrease in the values of „V".
The average stature of the girls under the age of 12 in this research was 1.56 m, their weight was 45.88 kg, and R=47.00 kg, which is a big difference between the minimal and maximal values of the kilograms for 12-year-old girls. We also calculated the Body mass index, whose values also had a high R=13.08 kg/m^2 . The mean value was 18.81 kg/m^2 for this age group; the normal value should vary from 16.30 kg/m^2 to 21.10 kg/m^2. This shows that there is a normal degree of obesity among the girls in the country, but the highest value is X_{max}=26.50 kg/m^2, and that there are children who are overweight, and the coaches working with them should talk to these children's parents about a change in their diet. The horizontal stretch had a lower value than the average for this stature. It was X=1.55 m, which is not a good indicator for basketball because coaches look for children with higher stature and longer arms as early as the preliminary selection.

In our research, we were interested in the vertical stretch of the girls because the aim of the game is to make more baskets and to take part in more rebounds, but this does not depend only on the anthropometric indicators of the children but on the execution of the technical elements. The mean value of the vertical stretch of the girls was X=2.02 m, and R=0.43 m. It is interesting, that for all indicators where the body lengths are measured, the dispersion of the values of X around the mean arithmetical value showed the lowest values, while this was not the case with the indicators related to body circumferences such as "Chest circumference-pause" and "Chest circumference-difference". They showed higher values of S_6=7.689 cm and S_7=1.468 cm. The mean values of these indicators were X_6=78.23 cm and X_7=6.46 cm.

The results from the variation analysis of the indicators of the girls under the age of 14 (Table 2) showed that most values of the researched indicators also had a normal distribution. The indicators where there was a little deviation from the normal distribution of As and Ex were "Weight" and "Chest circumference-pause". The values of the range were high - R_2=66.90 kg and R_6= 34.00 cm, but the average weight was 59.62 kg, while the mean value of the chest circumference-pause was 86.18 cm. The average stature of the girls was 1.66 m; their weight was 59.62 kg. The calculated Body mass index had a high value of R_3=15.90 kg/m^2, but the mean value was 21.46 kg/m^2 for this age group, and it should vary from 17.60 kg/m^2 to 22.70 kg/m^2. This shows that there is a normal obesity level for girls in the country. However, the highest value along this indicator was X_{max}= 31.37 kg/m^2. Therefore, there was also an overweight child, but we informed the coaches working with her and they had a conversation with her parents about her diet and the increase in the training load.
The horizontal stretch had a mean value equal to the average one for the stature X_4=1.66 m. this is not a good indication for basketball because coaches look for children with longer arms, especially the girls in this age group, who are in their puberty phase, are not expected to grow much after the end of the second phase. Of course, there may be singular cases, but generally, very few of them grow a lot.
As we have already noted, the vertical stretch of the girls is particularly interesting for our research. The mean value of the vertical stretch of the girls under the age of 14 was X_5=2.14 m and R_5=0.45 m. Here, again, for the indicators where the body lengths are measured, the dispersion of the values of X around the mean arithmetical value showed the lowest values. At the same time, this was not the case with the indicators related to body circumferences, such as "Chest circumference-pause" and "Chest circumference-difference". There were higher values of S_6=6.369 cm and S_7=1.184 cm. The mean values of these indicators were X_6=86.18 cm and X_7=7.38 cm.

The results from the variation analysis of the indicators of the girls under the age of 16 (Table 2) showed that the values of the observed indicators had a normal distribution, and there was a deviation of the normal distribution only as regarded weight. The average stature of the girls in this age group was 1.68 m, and their weight was X_2=62.82 kg. The calculated Body mass index also showed a high value of R_3=14.06 kg/m^2, but the mean value was 22.26 kg/m^2 for this age group, and the normal value should vary from 18.40 kg/m^2 to 24.10 kg/m^2. This showed that there is a normal degree of obesity among girls in the country. However, the highest value along this indicator was X_{max}=30.06 kg/m^2, which showed that there was a child who was overweight and the coaches working with her have already had a conversation with the parents about a change in her diet. The horizontal stretch had a mean value X_4=1.69 m, only one centimeter more than the average stature.

The mean value of the vertical stretch of the girls was X_5=2.16 m, and R_5=0.37 m. Here, again, for the indicators where the body lengths are measured, the dispersion of the values of X around the mean arithmetic value was with the lowest values. At the same time, this was not the case with the indicators related to body circumferences, such as "Chest circumference-pause" and "Chest circumference-difference". There were high values of S_6=5.396 cm and S_7=1.259 cm. The mean values of these indicators were X_6=87.86 cm and X_7=7.52 cm.

In order to solve the aim and tasks of the research, we made a comparative analysis of the results obtained from 173 female players aged 12 to 16 years (U12, U14, and U16), playing for different clubs in Bulgaria. Figure 1 presents the dynamics in the physical development of the researched seven indicators for the girls aged from 12 to 16 years.

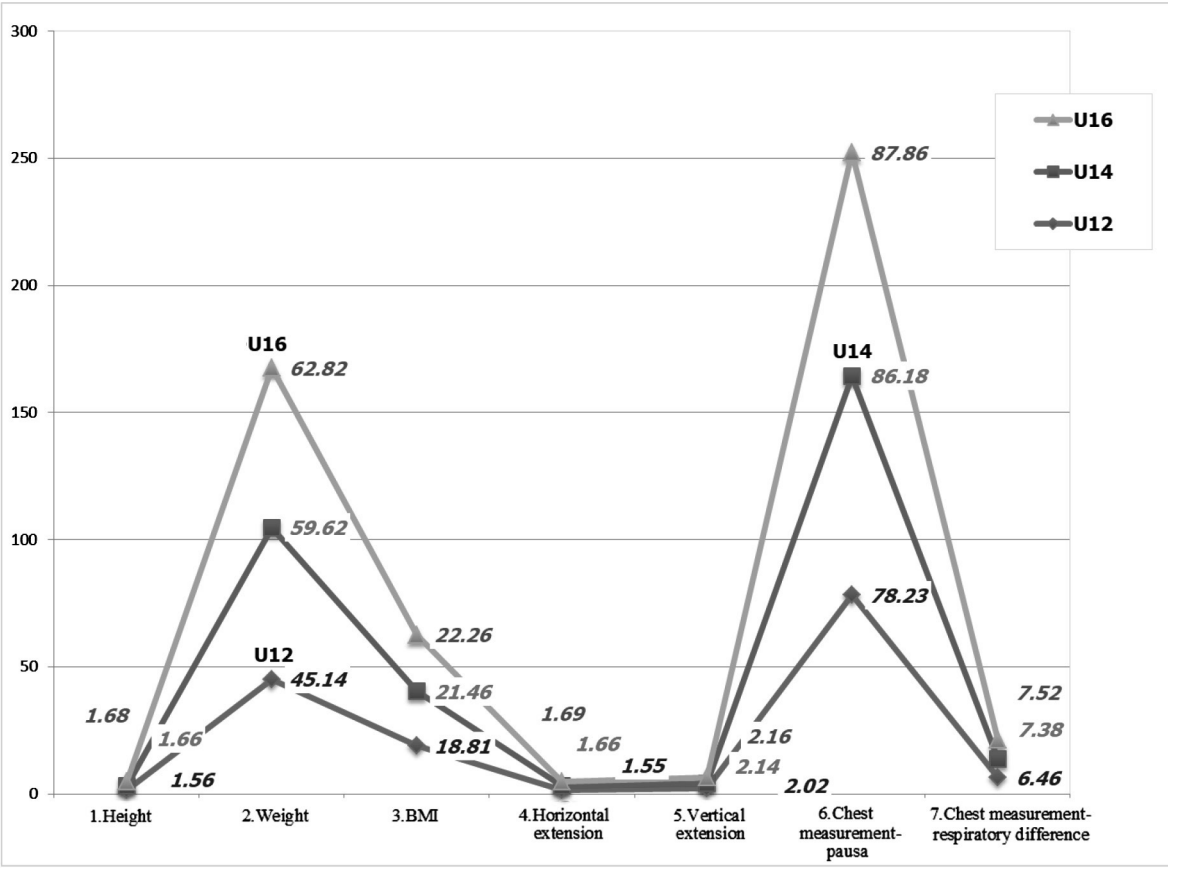

Figure 1. *Dynamics of the indicators of the physical development of the girls from U12, U14, and U16*

The analysis of Figure 1 shows that with the advancement in age, there is an increase in the average levels of the indicators of physical development. Similar dynamics are also observed along this group's third indicator – the Body mass index, but its values were within the norm for each age group. We can see in the figure that the average stature of the girls under the age of 12 was 1.56 m. In the age group 14, there was an abrupt increase in the stature with 10 cm, while the girls aged 16 showed maintenance of the stature compared to those aged 14, and the difference was only 2 cm in favor of U16.

As regards the horizontal stretch, the increase was not very regular either, and similarly to the previous two indicators, the fastest development was observed again at the ages of 12 and 14. Among the researched female players, the shorter stature supposed lower values along the indicators horizontal and vertical stretch which can be seen from the mean values of these indicators for the 14 and 16-year-olds, where the difference was 2 cm. We observed the same regularities in the vertical stretch as well.

The speed of development of the body weight is close to the one of the statures. The most significant rise along this indicator can also be observed in the age between 12 and 14 years when the average

difference in the weight of the basketball players is around 15 kg, or at the moment when some of the girls end their puberty period.
We can summarize that the girls at the age of 12 to 14 years show the greatest increase along the indicators related to body lengths, such as stature and horizontal and vertical stretch.

As for the indicators related to chest circumference, the greatest development of "Chest circumference-pause" and "Chest circumference-difference" is observed between the ages of 12 and 14. Regarding the "Chest circumference-pause", we found a minimal difference between the mean values of the two groups. This shows that the female players from the two groups had approximately the same degree of chest development, and the difference between them was ± two years. There was absolutely the same situation regarding the chest's functional capacity. The difference was 0.14 см. This shows that there was some negligence in the selection of the girls under the age of 16. Therefore, in their future work, coaches should try to find taller girls for their teams.

In order to check the zero hypothesis about the significance of the observed differences between the mean levels of the researched indicators in different totalities (female basketball players from U12; U14, and U16), we performed a one-factor dispersion analysis. We calculated Fisher's F-criteria at a high statistical probability level (Pt ≥ 95 %). Table 3 presents the dispersion criteria obtained when we compared the researched indicators of the girls. There is a comparison only of the intergroup dispersion.

Table 3. *Dispersion criteria for the girls (Ftabl =3.34)*

№	Indicators	F(emp)	Sig.
1.	*Height*	54.28	.000
2.	*Weight*	52.73	.000
3.	*Body Mass Index*	22.69	.000
4.	*Horizontal extension*	22.91	.000
5.	*Vertical extension*	44.59	.000
6.	*Chest measurement - Pause*	37.21	.000
7.	*Chest measurement - respiratory difference*	37.21	.000

The high values of F show the strong influence of the factor age on the development of the major anthropometric indicators of children (Borukova, 2021). The analysis of Table 3 shows that the calculated values of the F-criterion of Fisher for all indicators were higher than the critical one (Ftabl=3.34). This enables us, with a high guaranteed probability, to reject the zero hypothesis and to accept the alternative one, according to which the observed differences between the mean values of the researched indicators of the groups are significant. This fact is confirmed by the significance level α, which took values below 0.05. The analysis shows that a higher value of F is observed along all the researched indicators for the girls. The result from the comparison enables us to conclude that girls are positively influenced by their age as regards their anthropometric characteristics.

DISCUSSION

The researched female players were schoolgirls. In this period, the stature and the other body lengths constantly increase, and the speed of the increase for the girls is the greatest between 10 and 13 years (Slanchev, 1992). The indicators which characterize it do not change parallelly, such as stature and weight. The most considerable elongation is observed at the age of 12-14, which was also proven in our research. A characteristic of the basketball game is that stature does not have such a significant influence at a younger age and is not crucial. Still, this is usually one of the leading factors after age 16. Between the ages of U14 and U16, the dynamics of development of the indicators of physical development is not so big, which shows that for the girls, the age between U12 and U14 (the period of puberty development) is the most important. These dynamics of the changes in physical development is determined to a great extent by puberty development which is characterized with two phases: the phase of pubescence and the phase of maturation.

In surveys made over many years, it has been found that the female basketball players aged 12 to 19

years nowadays show much lower results than the generations in the past. There is a downward annual trend (Tzarova & Borukova, 2012). Unfortunately, the lower level of the female players is also confirmed by the inability of Bulgarian national teams to qualify for the A Division of the European Championship in the three age groups– U16, U18, and U20. According to our observations, one of the major problems of our girls is their selection. The Bulgarian children playing basketball are shorter and plumper, which, accordingly, influences their sports realization.

The more alarming fact, however, is that coaches do not have any desire to carry out sports-pedagogical testing. They believe this takes their time for training and worry that this would lead to some kind of control and evaluation of their teams.

The obtained results objectively reflect the level of physical development of all female basketball players from different age groups. The major problem is the selection of the girls in the younger age groups, which influences the older age groups in the future.

REFERENCES

American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD). (1984). Basketball for boys and girls: skill test manual VA: Reston

Asparuhov, Ya. (2020). Analiz na antropometrichnite pokazateli i spetsifichnata rabotosposobnost pri podrastvashti basketbolisti, Godishnik na NSA. NSA Pres, ISBN 2682-9908 (print), Broy 1, str. 15-22 // Аспарухов, Я. (2020). Анализ на антропометричните показатели и специфичната работоспособност при подрастващи баскетболисти, Годишник на НСА. НСА Прес, ISBN 2682-9908 (print), Брой 1, стр. 15-22.

Borukova, M. (2018). Control na sportnata podgotovaka pri 13-14 godishni basketbolistki. Sofia, Bolid ins. ISBN 978-954-394-242-8 // Борукова, М. (2018). Контрол на спортната подготовка при 13-14 годишни баскетболистки. София, Болид-инс. ISBN 978-954-394-242-8

Borukova, M. (2021). Kontrol na fizicheskoto razvitie pri mladi basketbolisti, *Sport i nauka, broy 3-4*, Sofiya, str. 11-22 // Борукова, М. (2021). Контрол на физическото развитие при млади баскетболисти, Спорт *и* наука, брой 3-4, София, стр. 11-22.

Borukova, M. (2022). Kompleksna sistema za kontrol i otsenka na fizicheskoto razvitie i spetsifichnata rabotosposobnost na podrastvashti basketbolisti, Disert. DS, NSA, Sofia // Борукова, М. (2022). Комплексна система за контрол и оценка на физическото развитие и специфичната работоспособност на подрастващи баскетболисти. Дисетр.ДН, НСА, София.

Giocheva, K. Tzarova,R & Tzarov, K. (1990). *Sisrema za kojrol, otzenka I optimtzirane na sportnata podgotovka na momicheta I momcheta – 13-15 godini*. Sofia, ETZNPKFKS-IPB, pp.6. // Гьошева, К., Църов, К. & Църова, Р. (1990). Система за контрол, оценка *и* оптимизиране на спортната подготовка на момичета *и* момчета – *13-15* години. София, ЕЦНПКФКС – ИПБ, стр.6.

Slanchev, P. (1991). *Sportna meditsina*. Sofiya: Meditsina i fizkultura // Слънчев, П. (1991). Спортна медицина. София: Медицина и физкултура.

Tsarova, R., Borukova, M. (2012). *Sistema za otsenka i kontrol na sportnata podgotvenost na uchenitsite ot sportnite uchilishta,* pp. 49-71, Bolid ins., Sofiya. // Църова, Р., Борукова, М. (2012). Система за оценка *и* контрол на спортната подготвеност на учениците от спортните училища, стр. 49-71, Болид инс., София.

Karalejič M., Jakovljevič S. (1998). *Testiranje i meranje u košarci*, KSS, Beograd.

Pattison, M. (1990). *Basketball: tests and measurements*. Australian Basketball Federation. Edgecliff.

Pino-Ortega, J.; Gómez-Carmona, C.D.; Nakamura, F.; Rojas-Valverde, D.(2020). Setting Kinematic Parameters That Explain Youth Basketball Behavior: Influence of Relative Age Effect According to Playing Position. *J. Strength Cond Res*., in press.

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SIGNIFICANCE OF SPEED TESTS WITH MAXIMAL AND SUBMAXIMAL INTENSITY REFERRED TO ANAEROBIC CAPACITY IN ADOLESCENT VOLLEYBALL PLAYERS

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ABSTRACT
One of the major problems in strength and conditioning of volleyball is connected with development and control of the anaerobic capacity. At this point, the aim of the study is to research the significance and the possibility of evaluating the speed test that characterizes anaerobic capacity in volleyball. The tasks of the research are: To establish a correlation between speed tests with maximal and submaximal intensity; To determine the relationship between indicator that characterizes anaerobic capacity and speed abilities. The study group was 19 female volleyball players of the under-18 national team of Bulgaria. Methods: To determine the anaerobic capacity and the indicators that characterize it we used the Wingate laboratory test and anthropometric indicators. Field tests were measured through chronometry. The results of the test were further analyzed by statistical methods. Results: The data from the descriptive statistics define the study group as homogeneous. Variation coefficient vary from 3.47% to 17,85%. This is a reason to assume that the received correlation results would be reliable enough. The research identified a high correlation between the speed tests with maximal intensity and the two types of test with submaximal intensity (r = .714; r = .732) but the high and significant correlation between the height of the subjects and the shuttle running type 1 (r = .714) were basis to recommend implementation of the shuttle running type 2 as a field test that characterizes anaerobic abilities in female volleyball players. A negative correlation between the results in sprint tests and the Wingate test determined that better results of speed tests correspond to: higher relative minimal power; smaller power decrement and coefficient of fatigue. At the same, time moderate correlation between results in speed tests and peak power and a negative moderate correlation between speed tests and relative peak power could be interpreted as underdeveloped anaerobic capacity.

Keywords: *volleyball, adolescent, anthropometry, anaerobic capacity, speed tests*

INTRODUCTION

It is a well-known fact that speed abilities with maximal and submaximal intensity are essential for intermittent and speed-strength sports in order to accelerate the body or any part of it when performing some movement (Peev, 2014, Comfort et al., 2014; McFarland et al., 2016). The literature review discloses that some authors research anaerobic power via the Wingate test and its indicators as a predisposition for the realization of speed-strength abilities. In other smaller parts of the researchers used the relationship of these indicators with the speed abilities with maximal and submaximal intensity (Kasabalis et al, 2005; Gacesa et al, 2009; Nikolaidis et al, 2016; Peev et al, 2017; Peev et al, 2017).

As a whole, there is a lack of information that can disclose their essence and importance in youth female volleyball players. All of this defines the ***aim*** of the present study. It boils down to optimizing the control of the level of anaerobic capacity in adolescent volleyball players, by revealing the importance of maximal and submaximal intensity tests.

The task of the research are

Research of the variability of the anthropometric, performance, and physiological indicators that characterize the anaerobic power

Research of the significance of tests used in practice that characterize speed abilities with maximal and submaximal intensity by revealing their correlation with the studied indicators.

METHODS

The study group is 19 female volleyball players of the Bulgarian national team at the age of 16-17. The tests were made at the beginning of the competition period of season 2022. The tests were made in two days. On the first day the field tests and on the second day Wingate test. Prior to the research, coaches and their players had been informed about the aim of the experimental study

and its procedure. Approval and consent were taken together from the p\arents and all respondents of the research.

Research methods are: anthropometry, performance testing, exercise bike test and statistical procedures. The research indicator of these tests is displayed in Table 1.

Table 1. *Tests, indicators, and measurement units of the research*

№ of the indicator	Indicator	Measurement units
1	Height	cm
2	Weight	kg
3	Weight to height ratio	g/cm
4	„Volleyball shuttle“	s
5	„4 x 20 m Shuttle running“	s
6	20 m running from standing start	s
7	Peak Power - PP	W
8	Average power - AP	W
9	Minimal power - MP	W
10	Power decrement - PD	W

The weight and the height of the volleyball players were measured with an electronic scale (DB II, Cas Co., USA) and a stadiometer (Seca-213, SECA, Leicester, UK). The weight to height ratio index is obtained as a quotient of the two values.

In terms of indicators 4 and 5 characterize speed abilities with the maximal and submaximal intensity we used two field running tests – Volleyball shuttle and 4x20 m shuttle. The total running volume for the first test is 30 m and 80 m for the second one. The way of execution is shown in Figures 1 and 2 as both tests are run in pairs. The results are measured to hundredths of a second with a manual stopwatch (Q&Q-HS45J002Y, CBM Corporation, Japan).

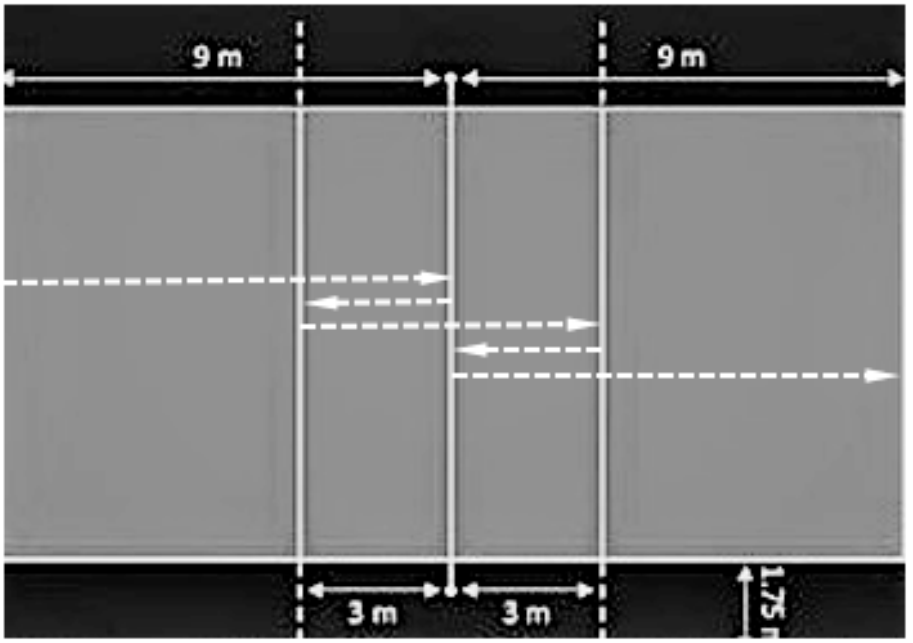

Figure 1. *Execution scheme of the volleyball shuttle test*

The level of speed abilities with maximal intensity (indicator 6) we research through the test 20 m running from standing start. The results were measured in seconds via a portable speed measurement system (Newtest Powertimer 10100, Newtest Oy, Finland). All of the players start from a standing position 30 cm behind the first photocell and run alone with the main goal to achieve as short as possible time.

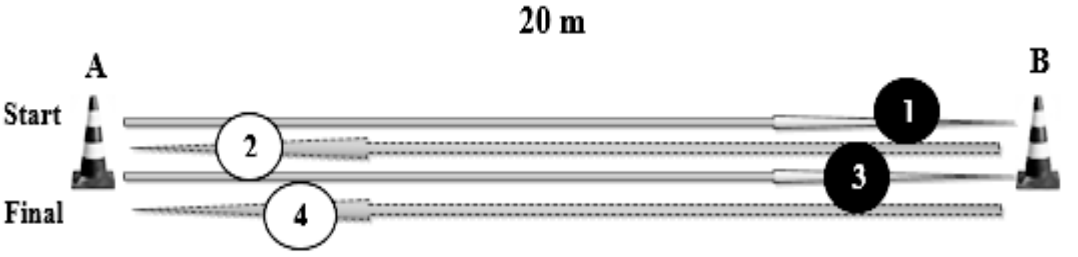

Figure 2. *Execution scheme of the 4x20 m shuttle test*

Physiological indicators are measured via the Wingate test. It consists of 30 seconds of pedaling at maximum power, against resistance equal to 7.5% of the body mass. We took the test on an exercise bike (Monark 894, AB, Sweden) with standardized procedures. That includes: Warm up and Test procedures that are thoroughly described in the literature (Walker, 2016).

Warm-up

Start cycling – The participant must cycle at 60 revolutions per minute (RPM) for 3-4 minutes at 60W (females) or 90W (males).

Adding the test weight – Halfway through the warm-up, the participant should briefly stop cycling, the test administrator should then add the test weight. Once the weight has been added, the administrator should then raise the basket away from the flywheel so that the participant can continue cycling at 60rpm with no resistance.

Warm-up sprint – With the resistance still raised above the flywheel, a 3-second countdown should begin. The subject must still pedal at 60rpm until the countdown is over. The test administrator should count down "3 – 2 – 1 – GO!". On the 'Go' signal the administrator must lower the test weight basket and the participant must accelerate maximally from 60rpm to a maximal speed for approximately 3-seconds. After ~3 seconds – once the pedaling speed is high, the administrators should clearly shout "STOP" and should remove the test weight so that the athlete can continue cycling, without the test weight, for another minute or so. After the 4-minute warm-up is over, the subject should rest for two minutes before performing the sprint test.

Protocol

The participant should begin cycling at 60 rpm for approximately 10-seconds with no weight. The test administrator should count down "3 – 2 – 1 – GO!". On the "GO" signal, the administrator must lower the test weight basket and the participant should begin to accelerate maximally and try to maintain maximal speed throughout the entire 30-second test. Test administrators provide verbal encouragement throughout the test. At the end of the test administrator should countdown the final 3-seconds of the test "3 – 2 – 1 – STOP". Once the test is over, some subjects may react to the previous exertion. To reduce any problems, the subjects must stay on the ergometer, cycling at 60-80rpm without any resistance, for at least 2-3 minutes. If the subject feels ill or goes quiet or pale, they should get off the bike and lie down with their feet resting on a chair. Note: never leave the participant alone after the test.

From the received data we used only the following physiological indicators:

- Indicator 7 (Peak power – PP), measures the achieved peak power of the test;
- Indicator 8 (Average power - AP), measures the average power of the test;
- Indicator 9 (Minimal power – MP), measures the minimal power for the interval of 5 seconds of the test;
- Indicator 10 (Power decrement – PD), calculates the difference between the PP and the MP.

RESULTS

The results of all tests and their descriptive statistics are summarized in Table 2.

Table 2. *Variability of the research indicators*

Indicators ⇨ Statistics ⇩	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
X	182.79	72.72	0.400	14.89	16.61	3.48	682.26	516.03	319.37	362.89
S	7.31	7.94	0.03	0.74	0.58	0.14	74.96	50.08	53.69	64.79
As	-0.53	0.31	-0.15	-0.07	-0.14	-0.31	0.06	0.35	-0.93	0.10
Ex	1.47	-0.57	-0.89	-0.91	-1.61	-0.70	-0.87	0.71	1.66	-0.23
Range	33.00	27.50	0.110	2.67	1.65	0.51	260.99	218.95	232.35	260.86
X min	165.00	60.50	0.340	13.60	15.72	3.21	562.66	414.98	182.22	234.73
X max	198.00	88.00	0.450	16.27	17.37	3.72	823.65	633.93	414.57	495.59
V%	4.00	10.92	8.34	4.97	3.47	4.11	10.99	9.70	16.81	17.85

From Table 2 is obvious that all of the coefficients of variation are in the interval between 3,47 and 17,85 %. It must be noted that all of the results of the researched indicator are highly homogeneous except indicators 9 (MP) and 10 (PD) of the Wingate test. The coefficients of Skewness and Kurtosis are in norms for the research group which is the basis for accurate conclusions. The correlation of the research indicators is presented in Table 3.

Table 3. *Correlation analysis of the research indicators*

Indicator ⇩ ⇨	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1	.731	.472	.547	.320	.177	.681	.693	.360	.489
2		1	.946	.498	.447	.350	.881	.820	.585	.535
3			1	.385	.427	.369	.819	.728	.590	.459
4				1	.800	.714	.410	.306	-.041	.469
5					1	.732	.463	.388	-.048	.480
6						1	.199	.126	-.041	.365
7							1	.913	.535	.714
8								1	.655	.513
9									1	-.210

From the presented correlation of the researched indicators can be made some conclusions that will be reviewed below.

DISCUSSION

The first part of the analysis is connected with the correlations of the anthropometric indicators presented in Table 3. It is obvious from the table the high correlation (r = .946) between indicators 2 and 3. At the same time correlation between indicators 1 and 3 is moderate (r = .472). These results suggested that the weight-to-height ratio is highly dependent on the weight of the study group. It is a well-known fact that the weight-to-height ratio characterizes the shape and structure of the body. If we compare the accepted norm for a standard on this basis (357-408 g/cm) with the values from the variation analysis (Table 2), we could find an increase in the value of the average value (400 g/cm) and especially of the maximum values (450 g/cm). The question of the influence of anthropometric indicators on speed abilities is one of the interesting topics for sport science specialists. Based on the correlation coefficients, it is obvious that the results of the speed test (Indicator 6) haven't relationship with height. At the same time weight and weight to height ratio have moderate correlation (r = .350 and r = .369). In conclusion, we can claim that anthropometric indicators have little effect on the speed abilities with maximal intensity. The picture is different in terms of correlation between anthropometric and speed tests with submaximal intensity (4 and 5), that characterizes the anaerobic power. Regarding the weight and weight to height ratio correlation is moderate. The difference is in terms of the height feature. The achieved correlation (r = .547) between the height and the "Volleyball shuttle" is the basis for some assumptions. They are related to the fact that as the height increases, the achievement will deteriorate and vice versa, as the height values decrease, the values of the shuttle running will improve. In other words, the height greatly influences the result of this test which cannot give an objective information regarding the as-

sessment of anaerobic capacity. In this regard, we would suggest that this test could be used in the training process to develop anaerobic capacity, but not to evaluate it. At the same time, the established moderate correlation between the anthropometric indicators (1, 2, 3) and the speed indicator 5, outlines the smaller and equivalent influence on the achievement of the latter. This is also our reason for claiming that the data from indicator 5 will be more objective for assessing anaerobic capacity than those from indicator 4. All of these assumptions suggest that the "4x20 m shuttle running" test is a better test for evaluating the anaerobic capacity of young volleyball players.

The high correlation between speed indicators with maximal and submaximal intensity (r = .714 and r = .732) discloses two major conclusions. First of all, both of them reflect the level of development of the anaerobic capacity that characterizes speed endurance and second of all, they strongly influence each other in their development. This is confirmed by the high correlation dependence (r = .800) between the two-speed characteristics with submaximal intensity. All this requires the use of exercises with maximal and submaximal intensity in the training process, with a certain methodical approach and adequate planning. This way their synergistic effect will contribute to the development of anaerobic capacity. As it is known, anaerobic capacity is related to power production i.e., the speed-strength potential.

The next part of the research focused on the correlation between anthropometric and speed abilities indicators with these of the Wingate test. This analysis will help to reveal the influence and significance of the groups of indicators on the level of anaerobic capacity. The values of indicator 7 characterize the anaerobic alactate system of energy supply for motor activity (Inbar et al., 1996). The high positive correlation of anthropometric indicators 2 (r = .881) and 3 (r = .819) with indicator 7 suggests a great influence of weight and weight to height ratio index on the peak power. It is a common fact that PP is greatly influenced by muscle mass and its absolute values largely depend on it (Armstrong, et al., 2001; Driss, Vandewalle, 2013). All of this explains the high level of correlation that we found between these indicators.
Regarding the next important physiological indicator 8 (average power), we will note that it characterizes the power of the anaerobic lactate system of energy supply. The established correlations of the anthropometric indicators that we discussed above (2 and 3) are also applicable for indicator 8. This confirms and enforces the opinion that muscle mass affects these two physiological indicators to a high degree. In confirmation of this, we would note the very high correlation (r = .913) between signs 7 and 8.

A particular interest for practice is also the established moderate and significant correlation of anthropometric indicators 2 and 3 with the other two physiological signs 9 and 10. The lower values of the considered anthropometric indicators are related to lower values of indicators 9 and 10. Or, in other words, the lower anthropometric values of volleyball players correspond to lower values of the decline in anaerobic power and vice versa, higher anthropometric values are associated with a greater decline in the same. These values lead us to the assumption that, in general, the studied volleyball players developed insufficiently their anaerobic power. We can define this as a gap in the training process. As a confirmation of this, moderate correlations were found between indicators 4 and 5 with indicators 7, 8 and 10.

Regarding the internal correlation of the physiological indicators of the "Wingate" test, we will note the high correlation (r = .714) between signs 7 and 10. This proposes that higher peak power values correspond to a smaller decline in anaerobic power or in other words higher values of peak power is an expectation to achieve higher anaerobic power (speed endurance).

CONCLUSIONS

The data from the presented research are reason to make the following, important conclusions for sports practice:

- The two physiological indicators peak and average anaerobic power characterizing the anaerobic lactate energy supply system are highly influenced by muscle mass values;
- Higher peak power values correspond to less decline in anaerobic power. Or realizing higher peak power values is a predisposition and expectation for realizing a higher anaerobic capacity. In our case, we associate the latter with speed endurance;
- In addition to the fact that speed indicators with maximal and submaximal intensity define the level of anaerobic capacity, they influence each other in their own development. This way we can claim

that their synergistic interaction will contribute to the development of anaerobic capacity;

- The received correlation coefficients of the two speed tests with submaximal intensity, allow us to recommend the use of the field test "4x20 m shuttle running ". Data analysis determines it as a more valid test for assessing anaerobic capacity in young volleyball players. In this regard, it is necessary to conduct a larger-scale study allowing us to build an evaluation table for control of the performance;
- In general, the data from the studied anthropometric, performance and physiological indicators are reasons to claim that the studied group of volleyball players has an insufficient degree of development of anaerobic capacity. Having in mind that they represent some of the schools at the national level, we can assume that this is a result of a gap in the planning of the training process.

REFERENCES

Aziz, A. & The, K.C. (2004). Correlation between tests of running repeated sprint ability and anaerobic capacity by Wingate cycling in multi-sprint sports athletes, *International Journal of Applied Sports Sciences*, 16(1), 14-22;

Armstrong, N., Welsman, J. R. & Chia, M. Y. (2001). Short term power output in relation to growth and maturation, *British Journal of Sports Medicine*, April; 35(2): 118–124;

Comfort, P., Stewart, A., Bloom, L. & Clarkson, B. (2014). Relationships between strength, sprint, and jump performance in well-trained youth soccer players, *Journal of Strength and Conditioning Research*, 28(1): 173–7;

Driss, T. & Vandewalle, H. (2013). The Measurement of Maximal (Anaerobic) Power Output on a Cycle Ergometer: A Critical Review, *BioMed Research International*, Epub 2013 Aug 29

Gacesa, J. Z. P., Barak, O. F., & Grujic, N. G. (2009). Maximal anaerobic power test in athletes of different sport disciplines, *The Journal of Strength & Conditioning Research*, *23*(3): 751-755;

Hoffman, J. R., Epstein, S., Einbinder, M. & Weinstein, Y. (2000). A comparison between the Wingate anaerobic power test to both vertical jump and line drill tests in basketball players, *Journal of Strength and Conditioning Research*, 14(3): 261–4;

Inbar, O. & Skinner, J. (1996), *The Wingate anaerobic test*, Human kinetics, pp. 110j

McFarland, I. T., Dawes, J. J., Elder, C. L. & Lockie, R. G. (2016). Relationship of two vertical jumping tests to sprint and change of direction speed among male and female collegiate soccer players, *Sports, 4*(1): 11;

Kasabalis, A., Douda, H., & Tokmakidis, S. P. (2005). Relationship between anaerobic power and jumping of selected male volleyball players of different ages, *Perceptual and motor skills*, *100*(3): 607-614.

Nikolaidis, P. T., Afonso, J., Clemente-Suarez, V. J., Alvarado, J. R. P., Driss, T., Knechtle, B., & Torres-Luque, G. (2016). Vertical jumping tests versus Wingate anaerobic test in female volleyball players: The role of age, *Sports*, *4*(1): 9;

Peev, P. (2014). Interrelation between speed abilities and speed strength abilities and speed endurance of 13-14 years football players, *9th FIEP European Congress and 7th International Scientific Congress „Sport, Stress, Adaptation"*, (congress proceedings) Sofia 9-12 October, p. 1007;

Peev, P., Gadev, M., Hristov, O., Petrova, B. & Mihaylov, I. (2017). Vzaimovrazka mezhdu priznatsite harakterizirashti anaerobnata mosht i raznovidnosti na otskotsi vav vertikalnata ravnina pri 14-godishni futbolisti, *Leka atletika i nauka* 1,(17): 25-32;

Peev, P. ,Gadev, M. & Petrova, B. (2017). Changes in anaerobic power of youth soccer players in an annual training cycle, *Proceeding book of the International Congress "Applied Sports Sciences"*, 1-2 December 2017, Sofia NSA Press: 30-33 / ISBN: 978-954-718-489-3

Purvi, K. C. & Bhatt, S. (2012). The correlational study of the vertical jump test and Wingate cycle test as a method to assess anaerobic power in High school basketball players, *International Journal of Scientific and Research Publications*, June; 2 (6);

Ravier, G., Grappe, F. & Rouillon, J. D. (2004), Application of forcevelocity cycle ergometer test and vertical jump tests in the functional assessment of karate competitor, *Journal of Sports Medicine and Physical Fitness*, 44(4): 349–55;

Soslu, R., Özkan, A & Göktepe, M. (2016), The relationship between anaerobic performances, muscle strength, hamstring/quadriceps ratio, agility, sprint ability and vertical jump in professional basketball players, *Journal of Physical Education & Sports Science*, 10 (2): 164-73

Walker, O. (2016). Wingate Anaerobic test available at: https://www.scienceforsport.com/wingate-anaerobic-test/ (accessed 10.05.2018)

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ANALYSIS OF THE TACTICAL FORMATIONS USED IN GROUP "E" OF THE EUROPEAN UNDER-21 CHAMPIONSHIP QUALIFYING FOOTBALL COMPETITION IN THE 2021/22 SEASON

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ABSTRACT
Tactical formations play a crucial part in the outcome of every football match. The selection of a formation is based on various factors (e.g., the skill set of players on both teams, the particular vision of the coach, etc.) and is subject to dynamic changes throughout the course of the game. This paper aims to analyze the matches played in the European Under-21 Championship qualifying competition in the 2021/22 season and to assess the effect of the tactical formation on the overall performance of each team. To achieve this, a thorough comparative analysis was carried out on all 60 matches that have been played in the qualification group. Additionally, 70 Bulgarian coaches holding varying professional licenses were surveyed on their views and preferences in terms of tactical formations. The results of the analysis performed indicate a strong correlation between the best performing teams and the teams which employed the 1-4-4-2 tactical formation. Further, the data suggests that using both variations of the formation is more advantageous than strictly using only one. On the other hand, the survey suggested that the most preferred and commonly used formation among Bulgarian coaches is 1-4-3-3. Given these results, we propose that the 1-4-4-2 tactical formation should be one of the first to be considered when preparing for a match, with the specific variation being dependent on the particular skill set of the opposing team.

Keywords: *football, tactical formations, comparative analysis, Under-21*

INTRODUCTION

This study aims to analyze the tactical schemes utilized by the teams in group E of the European Under-21 Championship qualifying competition in the 2021/22 season and to determine the most successful formation based on the results of all the matches.

Tactical schemes play an important role in amateur as well as in professional football. They are such a fundamental component of the game that they can even be observed in tournaments with children as young as five years old. A tactical formation is the initial positioning of a team's players on the field and is determined by the number of defenders/backs, midfielders, and strikers/forwards in any given match. The goalkeeper is also a part of the formation, but as there is always a sole goalkeeper and his position never changes, he does not affect the selection of a tactical scheme.

For example, in the 1-4-4-2 system, the players on the field are one goalkeeper, four defenders, four midfielders, and two strikers. Due to the game's dynamic nature, the tactical systems undergo changes in the different phases of play (defense and offense phases). In the example of the 1-4-4-2 scheme, when attacking, the players might position in a 1-2-3-2-3 formation, and when defending, they might transition to 1-4-5-1. The most popular tactical formations used in football are 1-4-4-2 (with its two variants - classic and diamond), 1-4-3-3, 1-3-5-2, 1-3-4-3, 1-5-3-2, and 1-4-5-1.

Some great football specialists in the world of football, such as Cruyff, Guardiola, Klopp, Pochettino, and Bielsa, believe that the best offensive tactical scheme is the 1-4-3-3 with one defensive and two offensive midfielders, and it is widely accepted that the best scheme for quick transitions from offense to defense is the 1-4-4-2.
Every football coach, manager, or specialist has their unique understanding of the appropriate tactical formation for a team due to several factors such as football philosophy, club traditions, player profiles, the short and long-term goals of the team, etc.

METHODS

The main method used to achieve the aims of this study were a comparative analysis performed of the matches played in Group E of the European Under-21 Championship qualifying competition in the 2021/22 season, a survey developed and con-

ducted specifically for this paper across 70 Bulgarian football coaches holding varying coaching qualifications and the video analysis platform football.instatscout.com.

Every match of every team in Group E of the European Under-21 Championship qualifying competition was analyzed for a total of 60 matches. The initial tactical formation, results of every match, and the overall placing of each team have all been considered. The teams that placed first and second in the final placings were also compared. It is important to note that both of these teams used variations of the same tactical scheme. The system was studied further since the two teams that showed a preference for it not only were the two that qualified, but these two teams also finished the competition with some 15 and 11 points, respectively, ahead of the team that finished third. Additionally, the performance of each formation played was also considered.

The questions included in the survey were aimed at establishing the understanding and preferences of football coaches in Bulgaria regarding several key factors in selecting a tactical scheme, as well as the perceived advantages that a given scheme provides in both the offensive and defensive phases of the game. The coaches that took part in this survey hold the following coaching qualifications: UEFA PRO, UEFA A, UEFA B, and UEFA C licenses.

The video analysis platform football.instatscout.com was utilized to provide visual examples for the application of different initial tactical formations in the actual matches, as well as showing the dynamic way in which the initial setup changes throughout the game.

RESULTS

The most used tactical scheme in group E was 1-4-4-2, appearing in both its variants – classic and diamond. It was employed in 26 out of 60 games played in the group making it more than three times more common than the other popular formations – 1-3-4-3 and 1-5-2-3 – with both of the latter being played in 8 games. The breakdown of all the systems played and the number of times they were played is shown in table 1.

Table 1. *Tactical formation breakdown*

Formation	Times Used
1-4-4-2 classic	11
1-4-4-2 diamond	15
1-3-4-3	8
1-4-2-3-1	8
1-3-5-2	6
1-3-3-3-1	3
1-4-3-3	7
1-4-1-4-1	2

Besides being the most popular tactical formation in the group, the 1-4-4-2 system was also shown to be the most successful out of all schemes that were played in the competition, with 17 wins, six draws, and only three losses for teams playing 1-4-4-2. Table 2 below shows all games played as well as the tactical formations chosen for each team, and the result of each match is indicated by the color of the corresponding cell (green - win, yellow - draw, red - loss).

Table 2. *Game analysis*

Placing		NL	CH	MD	WALES	BG	GI	Points
1	Netherlands (H)	N/A	1-4-4-2 classic	1-4-4-2 diamond	1-4-4-2 classic	1-4-4-2 classic	1-4-4-2 diamond	26
	Netherlands (G)		1-4-4-2 diamond	1-4-4-2 diamond	1-4-4-2 classic	1-4-4-2 classic	1-4-4-2 diamond	
2	Switzerland (H)	1-4-4-2 diamond	N/A	1-4-4-2 diamond	1-4-4-2 diamond	1-4-4-2 diamond	1-4-4-2 diamond	23
	Switzerland (G)	1-4-4-2 diamond		1-4-4-2 diamond	1-4-4-2 diamond	1-4-4-2 diamond	1-4-4-2 diamond	
3	Moldova (H)	1-3-4-3	1-3-3-3-1	N/A	1-3-5-2	1-3-5-2	1-3-4-3	12
	Moldova (G)	1-3-3-3-1	1-3-4-3		1-3-3-3-1	1-3-5-2	1-3-5-2	
4	Wales (H)	1-4-2-3-1	1-4-2-3-1	1-4-4-2 classic	N/A	1-4-4-2 classic	1-4-2-3-1	11
	Wales (G)	1-4-4-2 classic	1-4-4-2 classic	1-4-2-3-1		1-4-4-2 classic	1-4-4-2 classic	
5	Bulgaria (H)	1-4-2-3-1	1-4-3-3	1-4-3-3	1-4-3-3	N/A	1-4-3-3	10
	Bulgaria (G)	1-3-5-2	1-4-2-3-1	1-4-3-3	1-4-2-3-1		1-4-2-3-1	
6	Gibraltar (H)	1-3-4-3	1-3-4-3	1-4-3-3	1-4-3-3	1-3-5-2	N/A	1
	Gibraltar (G)	1-3-4-3	1-3-4-3	1-4-1-4-1	1-4-1-4-1	1-3-4-3		

NL -Netherlands CH - Switzerland MD- Moldova WALES - Wales BG - Bulgaria GI – Gibraltar

It is evident that despite the apparent popularity of the 1-4-4-2 tactical formation, not many of the teams in the group chose to utilize it in their matches. In fact, only half of the teams ever chose the above-mentioned tactical scheme - The Netherlands, Switzerland, and Wales. Notably, the Netherlands and Switzerland were also the teams placing highest out of the group with a huge point advantage over the third placer - Moldova. Taking a closer look at the matches of the Netherlands and Switzerland, it becomes apparent that even though both teams opted for the 1-4-4-2 scheme in all their games, the two teams had a different approaches to the application of the system and the variation chosen. While Switzerland decided to stick to the diamond variation of the 1-4-4-2 in all their games, the Netherlands employed both the diamond and classical variations against their different opponents. The breakdown of variations chosen for both teams is presented in table 3.

Table 3. *Netherlands - Switzerland comparison*

Team	Formation	Times Used
Netherlands	1-4-4-2 classic	5
	1-4-4-2 diamond	5
Switzerland	1-4-4-2 diamond	10

The difference between the two variations of the 1-4-4-2 tactical formation is the position of the midfielders on the field. In the classical variation, all four midfielders are placed in a line, allowing a quicker transition into defense. On the other hand, in the diamond variation, the midfielders assume a diamond or rhombus formation aiming to dominate the center.

Figure 1 and Figure 2 give a good example of the in-game application of the 1-4-4-2 system, respectively in a Netherlands and Switzerland game. In contrast, Figure 3 shows the difference between the two variations in one of the matches between the Netherlands and Switzerland.

Figure 1. *1-4-4-2 classic*

Figure 2. *1-4-4-2 diamond*

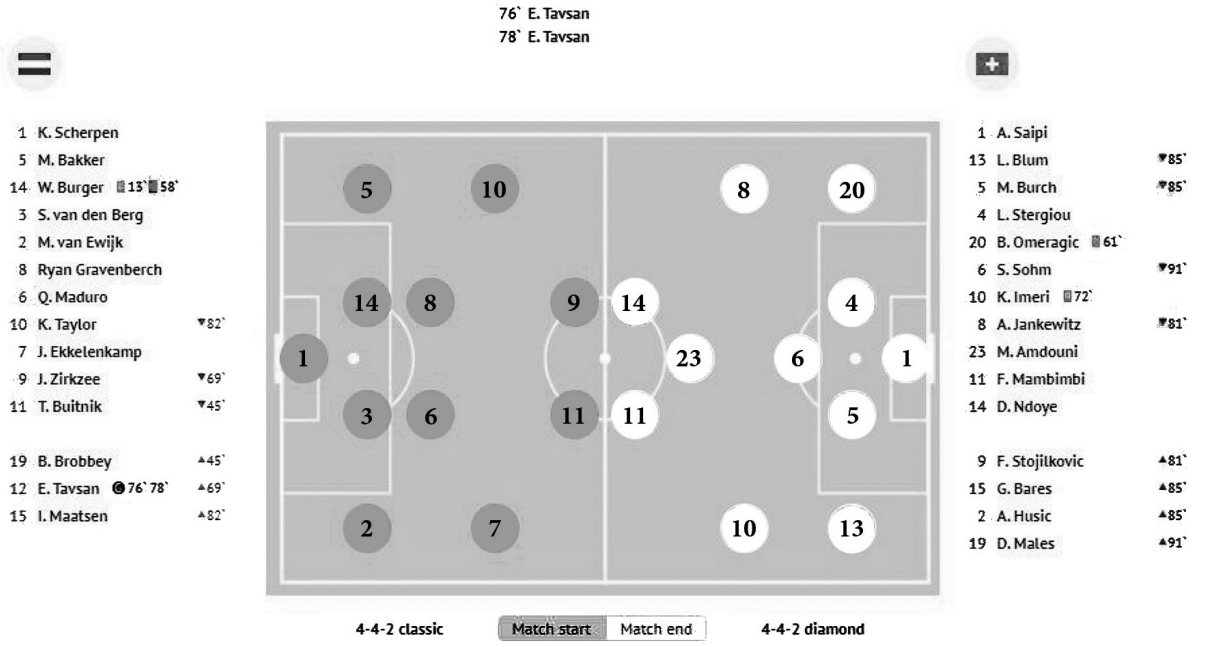

Figure 3. *Netherlands - Switzerland starting formations*

DISCUSSION

The results recorded in Group E of the European Under-21 Championship qualifying competition suggest that the 1-4-4-2 tactical system has many advantages over the other formations used. The main advantages of this scheme include: i) the opportunity it provides for a seamless and quick transition between the offensive and defensive phases of

the game; ii) the increased importance of the role of the goalkeeper who manages the defensive block, assuming the role of a libero of sorts; iii) more opportunities to reclaim possession of the ball in defense such as pressuring the player with the ball, maintaining a numerical advantage in the area of the ball and keeping the distance between the players on the team short.

Given the final results of the group, it can be assumed that in addition to the above-mentioned strong suits of the system, making use of both common variations provides different advantages in the different phases of play, and depending on the given opponent, using a combination of the classical and diamond 1-4-4-2 would prove beneficial.

The responses of the surveyed UEFA-certified Bulgarian coaches differ significantly from the analysis of the matches played in Group E of the European Under-21 Championship qualifying competition. While 1-4-4-2 is by far the most successful tactical scheme, the survey shows that Bulgarian coaches holding UEFA PRO and UEFA A licenses have a very strong preference for the 1-4-3-3, most of whom chose it as the system they use most often. The rest of the respondents showed a huge variation in preferred tactical formations. It is important to note that most of the coaches surveyed selected 1-4-4-2 as the best tactical system for defensive play and 1-4-3-3 as the best one for offensive play. This indicates that 1-4-4-2 could be less popular in Bulgaria due to the preferences of most coaches toward a more offensive playstyle.

In conclusion, the 1-4-4-2 tactical system shows, in addition to its theoretical advantages, that it is a system strongly preferred by the top-performing teams in the sampled group. Given this and the low favorability of the tactical formation across Bulgarian coaches, we believe that a more frequent implementation of the 1-4-4-2 would have an overall positive effect on the performance of Bulgarian teams.

To solidify the findings, several aspects of this study could be explored further in follow-up research on similar topics. These include increasing the sample size and analyzing if the finding would change based on age.

REFERENCES

Wei, X., Sha, L., Lucey, P., Morgan, S., & Sridharan, S. (2013). Large-scale analysis of formations in soccer. *2013 International Conference on Digital Image Computing: Techniques and Applications (DICTA)*. https://doi.org/10.1109/dicta.2013.6691503

Bialkowski, A., Lucey, P., Carr, P., Yue, Y., & Matthews, I. (2014). Win at Home and Draw Away": Automatic Formation Analysis Highlighting the Differences in Home and Away Team Behaviors. Conference: MIT Sloan Sports Analytics *Conference At: Boston, Massachusetts, USA*

Shaw, L., & Glickman, M.E. (2019). *Dynamic analysis of team strategy in professional football.*

Baptista, J., Travassos, B.F., Gonçalves, B., Mourão, P., Viana, J.L., & Sampaio, J. (2018). Exploring the effects of playing formations on tactical behaviour and external workload during football small-sided games. *Journal of Strength and Conditioning Research.*

Beal, R., Chalkiadakis, G., Norman, T., & Ramchurn, S.D. (2020*). Optimising Game Tactics for Football.* AAMAS.

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MOST USED TAEKWONDO KICKING TECHNIQUES

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ABSTRACT
In the recent years, taekwondo has become a global sport, gaining international reputation and prestige, establishing itself amongst the official sports of the Olympic Games.
With the globalization of taekwondo worldwide, the increasingly demanding requirements for practicing athletes, coaches and judges are inevitable. The aim of our study is to determine the types of kicking techniques used in a taekwondo match, as well as their quantitative dimensions.
Based on the videos from the Sofia Grand Prix 2019 in taekwondo, we established the number (3939) and the types (29) of kicks used in the matches of the -68 kg category for men. The preferred kicks of the competitors were identified, as well as the individual style of play of the winner of the category. The point efficiency of the surveyed athletes for all their matches was calculated (22.63%). The number of blows inflicted on average per match was determined (140.67), as well as the coefficient of intensity of inflicting kicks in each round (2.55).
We used observation, video analysis, expert evaluation, and statistical processing. The results showed that the competitors mainly used their front leg to strike. This has a serious impact on the training methodology. The number of kicks executed in a match and respectively in a taekwondo championship can have significant impact on the training methodology, as well.

Keywords: *martial art, sport, championships, training, performance.*

INTRODUCTION

Taekwondo is a Korean martial art and international sport that has gained more popularity in the last four decades. Since its introduction as a demonstration sport at the 1988 Seoul Olympic Games and then becoming an official medal sport since the 2000 Sidney Games, Taekwondo has developed tremendously. As of today, there are 2011 Member National Associations in the World Taekwondo with over 80 million people practicing taekwondo. A game changer for taekwondo as an Olympic sport was the introduction of the electronic protector and scoring system (PSS) at the 2012 London Olympics. The PSS is an electronic system in the protective gear of taekwondo competitors - trunk and head gear, which indicates the power and the accuracy of the kicks of the athletes. If the accuracy and the power of the kicks to the trunk and to the head gear are enough for the relevant weigh division, it is linked to the scoreboard wirelessly. The introduction of the PSS had huge influence on the techniques used in a sparring match. Rarely used techniques in the past are now considered the most often used techniques in the Olympic taekwondo. This fact has changed the way athletes prepare for a competition. What is more, the tactical and technical part of a sparring match has evolved significantly.

Aims and Tasks of the Research

The aim of this work is to analyze the most used taekwondo kicks during the 2019 Sofia Grand Prix. The Grand Prix series are competitions sanctioned and promoted by the World Taekwondo where the best athletes in the Olympic categories are invited to participate. The medalists win points for the Olympic ranking, which gives them the opportunity to qualify for the Olympic games directly through the Olympic ranking – the five players in each Olympic category qualify directly to the Games without further qualification. The research also shows the effect of using the electronic PSS in taekwondo competitions and the changes in the rules and regulations in the Olympics taekwondo. Figure 1 shows the electronic PSS which was used in the Rio 2016 and Tokyo 2020 Olympic Games – the second generation of the PSS. In London 2012 the first generation of this PSS was used (Figure 2).

Figure 1. *Electronic PSS Daedo Generation 2 (used in Rio 2016 and Tokyo 2020)*

Figure 2. *Electronic PSS Daedo Generation 1 (used in London 2012)*

METHODS

The study was conducted throughout live observation and video analysis of the most frequently used techniques by the male players under 68 kg division at the Sofia Grand Prix 2019. The competition was held in the capital of Bulgaria - Sofia from 18th October until 20th October in 2019. In the male category under 68 kg 29 contestants were included in the drawing lots and a total of 28 fights were played to determine the champion in this weight division. The video analysis is conducted through the World Taekwondo (WT) YouTube channel.

Table 1. *Main technical indicators during the Sofia Grand Prix 2019, male - 68 kg division*

Technique/ Kick	Left Leg	Right Leg	№ of total techniques/ kicks	No. of kicks per match	№ of scored kicks	Points generated by the kicks	Success rate	% of the total kicks	Efficiency of the kicks
Dollyeo-chagi (D.Ch.)	387	384	771	28	56	108	7.26	19.57	14.01
D. Ch. Front leg	385	459	844	30	30	60	3.55	21.43	7.11
D. ch. Head kick	39	50	89	3	22	66	24.72	2.26	74.16
D. Ch. Head kick front leg	74	52	126	5	23	69	18.25	3.20	54.76
Yop-chagi front leg	583	510	1093	39	48	96	4.39	27.7	8.78
Mireo-chagi	0	6	6	0	0	0	0.00	0.15	0.00
Naeryeo-chagi	3	2	5	0	0	0	0.00	0.13	0.00
Neryo-chagi anuro	6	15	21	1	2	6	9.52	0.53	28.57
Naeryeo-chagi bakuro	10	7	17	1	0	0	0.00	0.34	0.00
Naeryeo-chagi front leg	5	5	10	0	0	0	0.00	0.25	0.00
Jump Naeryeo-chagi	52	54	106	4	5	15	4.72	2.69	14.15
Jump D. Ch. Front leg	2	4	6	0	0	0	0.00	0.15	0.00
Jump D. Ch. Front leg head kick	1	9	10	0	1	3	10.00	0.25	30.00
Dwit-chagi	51	36	87	3	5	18	5.75	2.21	20.69
Dwit-chagi head kick	1	2	3	0	0	0	0.00	0.08	0.00
Momdollyo chagi – head kick	11	14	25	1	0	0	0.00	0.63	0.00
Momdollyo chagi - body	21	8	29	1	4	16	13.79	0.74	55.17
Turning kick - body	3	3	6	0	0	0	0.00	0.15	0.00
Turning kick to the head	0	0	0	0	0	0	0.00	0.00	0.00
Narrae-chagi	0	0	0	0	0	0	0.00	0.00	0.00
Hureyo-chagi front leg	3	0	3	0	0	0	0.00	0.08	0.00
Hureyo-chagi montong	2	1	3	0	2	6	66.67	0.08	200.00
Hureyo-chagi	0	0	0	0	0	0	0.00	0.00	0.00
Bituro-chagi	0	0	0	0	0	0	0.00	0.00	0.00
Jireugi	83	152	235	8	79	79	33.62	5.97	33.62
Dollyeo-chagi clinch	192	121	313	11	70	140	22.36	7.95	44.09
Naeryo-chagi clinch	108	23	131	5	32	96	24.43	3.33	73.28
Dwit-chagi clinch	0	0	0	0	0	0	0.00	0.00	0.00
Clinch	198	19	217	8	0	0	0.00	5.51	0.00
Total	**2022**	**1917**	**3939**	**141**	**379**	**778**			**19.70**

The analysis of male division under 68 kg included the division of the techniques used into left foot kicks and right foot kicks to determine the competitors' preferred kicking foot.

Presented in Table 1 is the total number of kicks for the left and right feet for the entire competition - 3939. Comparing left with right foot it is seen that the total number of kicks with the left foot is 2022 and with the right foot 1917. Although it is not significant, this difference in the numbers gives reason to claim that athletes from the category up to 68 kg prefer to use the left leg. Through this indicator, we can assess in which guard the competitor in question stands, which is also useful when preparing a tactical plan. However, this information alone is not enough to accurately analyze the opponent's game. For a more in-depth analysis, we first looked at data for the total number of kicks made with both legs – left and right leg, and then looked at the results for the left and right legs separately. The number of kicks which realized points during the entire competition was 379 scoring a total of 776 points. The total number of kicks for the entire competition in the observed category is 3939.

In table 2 the techniques that were most often used in the 2019 Sofia Grand Prix are summarized.

Table 2. *Summary of the most often used techniques in the 2019 Sofia Grand Prix*

№	Most often used techniques	Left leg	Right leg	Total	Front/ Back leg
1	Yeop-chagi	583	510	1093	Front
2	Dolleyo-chagi	385	459	844	Front
3	Dolleyo-chagi	387	384	771	Back
4	Clinch Dolleyo-chagi	192	121	313	Clinch
5	Jireugi	83	152	235	Hand
6	Clinch Naeryo-chagi	108	23	131	Cling
7	Dolleyo-chagi to the head	74	52	126	Front
8	Jump Naeryo-chagi	52	54	106	Front

There are 8 techniques identified as the most often used in the 2019 Sofia Grand Prix in the Olympic male division under 68 kg. An interesting fact is that the kicks classified on places number 2, 3, 4, and 7 are one technique but executed with different legs and on a different level – i.e. to the body or to the head. The overall taekwondo techniques identified at the Grand Prix are 29.

The results were analyzed with IBM SPSS 27 to statistically establish the success rate of the techniques used and the efficiency of the different taekwondo kicks used in the male category under 68 kg during the Sofia 2019 Grand Prix.

RESULTS

The most frequently used technique is Yeop-chagi with the front leg – 1093. This is 27.7% of the total number of techniques. However, the rate of success of this kick is 4.39 % which makes it not the most successful technique in championship. After Yeup-chagi with the front leg, the most frequently used kick is Dollyeo-chagi with the front leg – a total of 844 kicks (21.43 %) with the left and right front legs. The rate of success of the Dollyeo-chagi front leg is 3.55 %. The third most commonly used kick is Dollyeo-chagi chagi with the back leg – tried for 771 times, which represents 19.57 % with a success rate of 7.26%. Based on the analysis conducted, it is clear that the most commonly used technique is Yeop-chagi with the front legs, however, the most successful kick is Dollyeo-chagi with the back leg.

Regarding the techniques with the highest success rate – Hureyo-chagi left and right legs (66.67%) it should be noted that this kick is extremely rare due to the fact that it was only used 3 times throughout the competition – it was used 2 times with the right foot and 1 time with the left foot and this is 0.08 % of the total number of shots (3939). As we can see, this information does not give us enough data to be able to statistically prove its correlation to the final result in the Taekwondo matches. The "Jireugi" with the left and the right hands (235) has a success rate of 33.62 %, and the most successful leg kick is Dolyo chagi olgul with the back leg- totally used 89 times with the left and right legs, with a coefficient of 25 %. In second place is Clinch nero chagi left and right legs (131 times), with (24.43 %). Third place is to another kick from the clinch – Dolleyo-chagi (313 kicks) with a success rate of 22.36 %. From the results in Table 1 it can be concluded that the most successful kick is Dolleyo-chagi with the back leg,

but the most used techniques are with the front leg – i.e., Yeup-chagi with the front leg.

In conclusion, during the analysis of the male division in the Olympic category under 68 kg, the results show that the mostly used taekwondo techniques are Yeop-chagi with the front leg. Also, frequently used technique is the Dolleyo-chagi with the front and with the back leg.

The most scoring taekwondo technique is the Dollyo-chagi to the face with the back leg. The second most effective taekwondo kick during the 2019 Sofia Grand Prix is the Naeryo-chagi in clinch position. After the Dolleyo-chagi with the back leg and the clinch Naeryo-chagi, the Dollyo-chagi with the front leg is the third most scoring technique during the Grand Prix in Sofia.

DISCUSSION

Started as a Korean martial art, nowadays Taekwondo is an Olympic sport that is gaining more and more popularity every year. The number of international taekwondo events has been growing in the last decade, the number of the Member National Associations is also growing, and so are the participating counties in the World championships in the different division – seniors, juniors and cadets. A reason for the development of the Olympic taekwondo is the introduction of electronic protector and scoring system since the 2012 London Olympic Games and the constant improvement of this system. This is also accompanied with modifications in the rules and regulations for the sparing events. The evolution of the taekwondo sport has also led to development and changes in the taekwondo techniques used in kyourugi competitions.

REFERENCES

Kim, EJ M., and Martin, M. (2022, August 30). *How to qualify for Taekwondo at Paris 2024. the Olympics qualification system explained*. Olympics.com. Retrieved October 4, 2022, from https://olympics.com/en/news/pathway-to-paris-2024-taekwondo-qualification-system-explained

International Sports Federations. International Olympic Committee. (2022, June 7). Retrieved October 4, 2022, from https://olympics.com/ioc/world-taekwondo-federation

World Taekwondo Headquarters. (n.d.). Retrieved October 4, 2022, from https://kukkiwon.or.kr/front/pageView.action?cmd=%2Feng%2Finformation%2FtaekwondoSkill2

[World Taekwondo] World Taekwondo celebrate 25 years on the Olympic Programme. worldtaekwondo.org. (n.d.). Retrieved October 4, 2022, from http://www.worldtaekwondo.org/competition/view.html?nid=131436

YouTube. (n.d.). *World taekwondo*. YouTube. Retrieved October 4, 2022, from https://www.youtube.com/user/worldtaekwondo

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THE CORRELATIONS BETWEEN ANTHROPOMETRIC PARAMETERS AND MOTOR SKILLS AMONG FEMALE VOLLEYBALL PLAYERS AT AGE 11–13 YEARS OLD IN ALBANIA

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ABSTRACT
This study aims to identify a correlation between anthropometric characteristics and motor skills in female volleyball players aged 11–13. Methodology: The study examined the anthropometric characteristics and indicators of a special performance in volleyball of 20 volleyball players from Albania. Height, weight, BMI, and standing reach with one and both arms (blockade), indicators that are important for volleyball athletes, were measured when determining the anthropometric indicators. The special performance of volleyball players was determined by a test battery that included eight tests. The Pearson correlation coefficient (p-value) was used in the data calculation to find the relationship between the variables. Conclusions: The results obtained from statistical data processing through the Anova platform show no correlations between anthropometric parameters and the T-test. Otherwise, they show a significant relationship between speed endurance and height (r = -.47, p = .03) and between speed endurance and the standing reach test (r = -.48, p = .02). The results indicate that there are no significant correlations between height with blocking jump and running vertical jump (p>.05), among standing reach with blocking jump and running vertical jump (p > .05), and also among blockade with blocking jump and running vertical jump (p >.05). It is noted that there is a significant relationship between BMI and vertical jump (r = -.5, p = .01) and also between some anthropometric parameters and medicine ball throwing (p < .05).

Keywords: *correlation, motor skills, anthropometric characteristics, volleyball players.*

INTRODUCTION

The great attention of the scientific community is focused on the study of the anthropological status of children, which is the modern life conditions exposed to many risks. The manifestation of motor abilities, among others, depends on anthropometric parameters. Motor abilities in children are structurally different than in adults. The period of later childhood is characterized by slow but steady growth in height and weight and progress toward the greater organization of sensory and motor systems. Children gain rapidly in learning during later childhood and can function at increasingly sophisticated levels when performing motor skills. This period of continued slow growth in height and weight gives children time to adjust to their growing bodies.

Due to the structural differences in motor abilities in children compared to adults, the manifestation of motor abilities depends on anthropometric parameters. Height and weight are often used as indicators of children's health and nutritional status. Anthropometric monitoring of these measurements, together with the values of movement abilities and skills, provides more information about the development process of children. The nutritional status of children and adolescents is one of the important indicators of the health of young people, their mental and physical abilities, and their potential for normal and healthy growth and development (Lobstein, Baur & Uauy, 2004). It is assumed that a greater deviation from the optimal body weight is one of the indicators of the symptoms of a health disorder. Obese children had poorer performance, which included carrying or lifting their body mass (Casajús et al., 2007). Physical fitness or motor fitness is the ability to do physical activity, albeit both phrases are difficult to define (Gallahue, 1982). Physical fitness may be defined as the ability to accomplish everyday tasks without being fatigued; motor fitness, often known as motor ability, is the ability to complete daily tasks without becoming fatigued, refers to a person's performance skills as they are impacted by factors such as speed, agility, balance, and so on power and coordination (Gallahue, 2006).

Body size and proportions, body structure, and body composition are important factors in the growth and anthropometric development of pre-adolescent children, body stature and weight, both indicators of total body size, have been widely used with age and gender to identify children's anthropometric development. Physics is easy to observe and is useful in evaluating the outcomes of the basic pro-

cesses of growth and maturation, leading to a better understanding of variations in the stature of both children and adults. (Jürimäe, Jaak Jürimäe, 2001).

Motor learning refers to the relatively permanent gains in motor skill capability associated with practice or experience (Schmidt, Lee, 2005). Motor control is the study of the neural, physical, and behavioral aspects of movement (Schmidt, Lee, 2005).
This study aims to identify whether there is a correlation between anthropometric parameters and motor skills in female volleyball players between the ages of 11 and 13.

METHODOLOGY

Participants

The research was conducted on a sample of 20 girls, volleyball players aged 11-13, athletes of "Galaktikët" Sports Association in Tirana, Albania. The tests that will be administered to the study's participating children have received the parents' signed consent. The testing protocol was explained in detail to the subjects before the start of the test. Before starting the measurements and tests, we made sure that each child provided full health and was in optimal condition to undergo the tests.
The measuring took place in the same environment where they are trained normally, fulfilling all the necessary equipment. Each athlete had the right to two attempts, of which the best result was recorded. Two minutes of a break was between the trials, and a 5-minute break was between the tests. The testing process was preceded by a warm-up of about 15 minutes combined with some moderate-intensity exercises.

Measuring instruments

Anthropometric characteristics were determined by measuring five parameters which consisted on; height, weight, BMI, standing reach with one hand, and standing reach with both extended arms (blockade). The specifics of the volleyball sport were considered while selecting the anthropometric markers for the study.

Anthropometric characteristics include body height (*H*), Standing reach test, and standing reach with both arms *(blockade).* They were measured according to the standard protocols using standard equipment. The results were obtained with an accuracy of 1 centimeter. Body weight (*W*) and The Body mass index (*BMI*)- medical scales (Tanita Body Inner Scan). The results were obtained with an accuracy of 0.1 kilograms.

Tests

The basic parameters of the motor abilities were determined by using the battery of; T-tests for agility (with tennis ball displacement), speed endurance, standing long jump, standing vertical jump with two hands (blockade jump), running vertical jump, medicine ball throwing (2kg), catching and throwing tennis ball (30 sec) and sit and reach test.

Procedure

The mean arithmetic values and standard deviations for each parameter of the anthropometric features and motor skills were determined, while the connection between the anthropometric characteristics and motor abilities was obtained by using a Pearson correlation analysis by the ANOVA platform. The Pearson correlation coefficient (p-value) was used in the data calculation to find the relationship between the variables.

RESULTS

Table 1 shows the arithmetic mean values, maximum values, minimum values, and standard deviation of all variables of anthropometric characteristics for 20 girls of age 11-13 years old volleyball players.
Table 2 shows the arithmetic mean values, maximum values, minimum values, and standard deviation of all variables of motor abilities for 20 girls of age 11-13 years old volleyball players.
Table 3 shows the correlation values (correlation coefficient *r* and *p-value*) between anthropometric characteristics and motor abilities. The data in table 3 show that the correlation coefficient values generally correspond to those of a weak or moderate correlation. In no case did we notice a strong correlation between the two values. Referring to the p-value, it was noted that in most cases, they show that there is no significant relationship ($p > .05$). However, it was evident that when the correlation between the values is moderate, it is generally significant ($p < .05$). Based on the data shown in Table 3, it is evident that there was no high correlation between indicators of anthropometric parameters and motor abilities. Anyway, some moderate correlations and significant ones at the same time were noticed between speed endurance and height ($r = -.4$, $p = .03$), speed endurance and standing reach ($r = -.4$, $p = .02$), speed endurance and standing reach with both hands ($r = -.4$, $p = .03$), medicine ball throwing and weight ($r = .5$, $p = .00$), medicine ball throwing and BMI ($r = .4$, $p = .03$), medicine ball throwing and standing reach ($r = .4$, $p = .05$),

running jump and BMI (r = -.5, p = .01). Negative correlations were observed between anthropometric parameters concerning speed endurance and standing blockade jump.

Table 1. *Descriptive statistics of anthropometric variables*

	N	Average (Mean)	Max	Min	SD
Body height in cm	20	157.4	172	148	7.61
Body weight	20	51.565	84.2	34.7	11.88
BMI	20	20.64	28.5	13.9	3.9
Standing reach	20	201.4	223	186	9.4
Standing reach with both arms ***(Blockade)***	20	200.05	222	186	9.6

Table 2. *Descriptive statistics of motor abilities variables*

	N	Average (Mean)	Max	Min	SD
T-test	20	19.00	23.02	16.62	1.65
Speed endurance	20	28.32	30.63	25.44	1.73
Standing long jump	20	127.85	145	100	13.24
Medicine ball throwing	20	319.75	400	240	52.22
Catch & throw the tennis ball	20	20.1	26	14	2.86
Sit & reach	20	7.9	25	-3	6.12
Blockade jump, A	20	24.1	31	17	3.21
Running vertical jump, B	20	29.2	38	19	5.56

Table 3. *The correlation values between motor abilities and anthropometric parameters.*

		Height	Weight	BMI	Standing reach	Blockade
T-test	*correlation coeficient* ***r***	.05	.10	.04	-.02	-.00
	p-value	.8	.64	.83	.9	.96
Speed	*correlation coeficient* ***r***	-.47	-.32	-.11	-.48	-.48
	p-value	.03	.16	.64	.02	.03
St. long jump	*correlation coeficient* ***r***	.26	.04	-.12	.30	.28
	p-value	.25	.86	.58	.19	.22
Medicine Ball Throwing	*correlation coeficient* ***r***	.38	.56	.48	.43	.41
	p-value	.09	.0	.03	.05	.06
Catch & throw the tennis ball	*correlation coeficient* ***r***	.41	-.02	-0.25	.36	.38
	p-value	.07	.92	.28	.11	.09
Sit and reach(flexibility)	*correlation coeficient* ***r***	.11	-.07	-.10	.08	.10
	p-value	.6	.76	.66	.73	.66
Blockade jump	*correlation coeficient* ***r***	-.09	-.25	-.26	-.18	-.16
	p-value	.69	.28	.36	.44	.48
Running vertical jump	*correlation coeficient* ***r***	.35	-.26	-.52	.20	.27
	p-value	.12	.25	.01	.36	.24

DISCUSSION

Based on other studies related to correlations between anthropometric characteristics and motor abilities, there are different conclusions if there is or not a relation between them.

The obtained results indicate that overall there were no statistically significant connections between anthropometric parameters and motor abilities. Children's growth and development, as well as their anthropometric traits, have an impact on the performance of numerous motor activities (Malina et al., 1995). This fact, however, does not always hold. No statistically significant correlation of any anthropometric indicators variable with T-test, standing long jump, and blockade jump were found in the 11-13 years old girls. The overall obtained results indicate that there were no significant correlations between BMI and motor abilities.

Numerous studies have found a negative relationship between anthropometric factors (body height, body mass index, BMI) and explosive leg strength (Milanese et al., 2010; Podstawski & Boryslawski, 2012; Brunet et al., 2007). Certain research findings showed that the relationship between genetic factors and motor skills in the population of pre-pubescent children is rather weak.

The findings of the correlations between motor skills and anthropometric traits in a group of girls show a very low number of statistically significant while the results of numerous studies (Brunet,

Champut & Tremblay, 2007; Podstawski & Boryslawski, 2012; Milanese et al., 2010) confirm that there is a statistically significant correlation between anthropometric characteristics and motor skills in children. Several studies, however, indicated a moderate correlation between body composition and motor ability (Hensley et al., 1982; Pissanos et al., 1983; Malina et al., 1995). Numerous studies (Milanese et al., 2010; Podstawski & Boryslawski, 2012; Brunet et al., 2007), which are almost compatible with our study, have confirmed the negative correlation between anthropometric characteristics (body height, body mass, BMI,) and explosive leg strength.

CONCLUSIONS

Anthropometric measures are frequently used in the selection of new volleyball athletes to determine their motor abilities at the same time. According to our findings, it is hard to have an accurate overview of expectations based on the anthropometric parameters of children aged 11-13 years old because of various factors that directly affect their development and growth. Our findings revealed that the correlations between anthropometric parameters and motor abilities are weak and not highly significant. Hence, for how long children of this age, especially girls aged 11-13 years, are in the process of growth and development, the correlation between anthropometric parameters and motor skills becomes more and more difficult to determine and even more difficult to obtain as a reference. Development can be faster or slower at different times, and development rates can differ among individuals of the same age (Haywood, M.K., and Getchell, N. 2021). The ongoing, age-related process of change in movement, as well as the interacting elements in the individual, environment, and task that drive these changes, is referred to as motor development. Motor learning refers to the relatively permanent gains in motor skill capability associated with practice or experience (Schmidt & Lee, 2005). Motor control is the study of the neural, physical, and behavioral aspects of movement (Schmidt & Lee, 2005).

Physical growth and motor skill improvement are important components that can be impacted by structured physical activity.

REFERENCES

Brunet, M., Chaput, J. P., & Tremblay, A. (2007). The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: the Québec en Forme Project. *International Journal of Obesity,* 31, 637-643.

Casajús, J. A., Leiva, M. T., Villarroya, A., Legaz, A., & Moreno, L. A. (2007). Physical performance and school physical education in overweight Spanish children. *Annals of Nutrition and Metabolism*, *51*(3), 288-296.

Gallahue, D. L. (1982). Assessing motor development in young children. *Studies in Educational Evaluation*, *8*(3), 247-252.

Gallahue, D. L. (2006). Ozmun, John C. Understanding Motor Development.

Haywood, K. M., & Getchell, N. (2021). *Life span motor development*. Human kinetics.

Hensley Ld, East Wb, Stillwell Jl. Body fatness and motor performance during adolescence. *Research Quarterly for Exercise and Sport*. 1982; 53:133-140

Jurimae, T., & Jurimae, J. (2001). *Growth, physical activity, and motor development in prepubertal children*. CRC Press.

Malina, R. M., Beunen, G. P., Claessens, A. L., Lefevre, J., Eynde, B. V., Renson, R., ... & Simons, J. (1995). Fatness and physical fitness of girls 7 to 17 years. *Obesity Research*, *3*(3), 221-231.

Milanese, C., Bortolami, O., Bertucco, M., Verlato, G., & Zancanaro, C. (2010). Anthropometry and motor fitness in children age 6-12 years. *Journal of Human Sport & Exercise,* 5(2), 265-279.

Pissanos, B. W., Moore, J. B., & Reeve, T. G. (1983). Age, sex, and body composition as predictors of children's performance on basic motor abilities and health-related fitness items. *Perceptual and motor skills*, *56*(1), 71-77.

Podstawski, R., & Boryslawski, K. (2012). Relationships between selected anthropometric features and motor abilities of children aged 7 – 9. *Clinical Kinesiology,* 66(4), 82-90.

Schmidt, R. A., & Lee, T. D. (2005). Motor learning and control: A behavioral emphasis. *Champaign, IL: Human Kinetics*.

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BODY COMPOSITION ANALYSIS OF YOUTH FOOTBALL PLAYERS

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ABSTRACT
Football is the most popular game and is one of the most dynamically developing sport regarding training means, methods, and use of technologies. We are witnessing constant improvement of sport selection, increasing dynamics in both training process and speed of playing, etc. We find a lot of information regarding body composition of elite football players, but such information for adolescents is fragmentary.
The aim of the following study is to reveal real data of youth football players using special equipment (In Body 270) measuring in total 13 indexes. Respondents are players from the youth academy of PCS "Levski" Sofia in U13, U14 and U15 teams. All data is subject to statistical and expert analysis. The total number of respondents is 57 divided by three age groups.
The fundamental anthropometric indexes height and weight reveal logical increase as follows: average height increases from 159 cm (U13), 167 cm (U14) to reach 175 cm (U15). The corresponding average weight vary between 45,9 kg (U13) to 62,1 kg (U15). One of the easiest to measure index is BMI have average values for studied teams as follows: 17,9 (U13), 19,0 (U14) and 20,3 (U15). All other indexes as body fat, skeletal and muscle weight are analyzed in detail for the three age groups.
Based on received data and the development of evaluation tables we can control objectively body composition of youth football players. This way we can improve sport selection and training process. All experimental data must be used applying the individual approach for assessing the anthropometric and sexual development of the player.

Keywords: *football, adolescents, body composition*

INTRODUCTION

Determining body composition is a key measure of health and exercise capacity for both athletes and the general population. Body composition is a factor that contributes to athletic performance. The percentage of adipose tissue varies depending on age, gender and in athletes and depending on the practiced sport, training status, energy intake. Success in sports has been associated with specific morphological characteristics (Eston, Reilly, 2013) and its determination is an important component of the dynamic monitoring of sports performance interested in improving their maximum performance.

Athletes have lower levels of adipose tissue than non-athletes. Body fat percentages for high performing athletes vary widely depending on the sport and are 6-13% in men and 12-19% in women.

Changes in weight and body composition in athletes correlate with training status, training period, and energy intake.

Tracking weight and body composition in dynamics gives us useful information to guide the training process and food intake in athletes.

The study and determination of physique from anthropometric variables are an important part of the integral evaluation of an athlete, as they can be used both for the detection and selection of players, as well as to determine the placement in a specific sport discipline or position. (Zúñiga, De León, 2007)

In football, all parameters affecting performance (conditional, technical, tactical, age, etc.) have evolved over the years towards more specific and individual work both in the professional area and in training and talent identification.

Studies have also shown high correlations between body fat index percentage and sporting performance (Jar, 1999) in the case of football, according to Cabañas et al. (2009), muscle percentage is an important factor related to the distance travelled by players during a football match.

Although age and body composition are strongly associated, there is no clear consensus as to whether this relationship is positive or negative (Spehnjak et al., 2021). Leão et al. (2019) found increases in fat-free mass and decreases in fat mass with advancing age.

METHODS

The aim of the following study is to reveal real data of youth football players using special equipment (In Body 270) measuring in total 13 indexes. Respondents are players from the youth academy of PCS "Levski" Sofia in U13, U14, and U15 teams. All data is subject to statistical and expert analysis. The total number of respondents is 57 divided by three age groups.

Body height was measured under standard conditions. The InBody 230 body composition analyzer (InBody Co. Ltd., Cerritos, CA, USA) was utilized to measure body weight and body fat percentage (BF%), by applying the bioelectrical impedance method. The InBody 230 is a segmental impedance device, with a tetrapolar eight-point tactile electrode method using 20 and 100 kHz frequencies for each body segment. This method presents a sum of complex procedures which exclude the possibility of making errors and inaccuracies. InBody 230 is an accurate and convenient bioelectrical impedance analysis (BIA) instrument for measuring weight, total body water, lean body mass, muscle mass (skeletal), body fat mass, BMI, percentage of body fat, segmental analysis of lean body mass (right and left arm, trunk, right and left leg). After the InBody 230 was turned on and warmed up, the instrument processed the self-calibration method with self-testing in zero weight conditions, followed by an adjustment of the internal circuit. After calibration, the loadcell was set to zero kilograms. Any pressure or weight could cause inaccurate calibration during the self-calibration process. The analysis and data output were carried out according to the manufacturer's algorithm, including the BF% equation (Percentage of Body Fat (%) = Body Fat Mass/Body Weight × 100) and BMI (Weight in kilograms)/(Height in meters)*2. The InBody 230 impedance was measured while the participants were in a standing position and with hands holding grips. InBody 230 is a reliable device for soccer players in the current study with high ICC for percentage of body fat (≥0.98) and low SEM. The standardized protocol was applied according to the InBody 230 User Manual. The subjects entered the testing area and removed their shoes and socks and wore only light clothing. Once they were positioned on the InBody 230, their age, sex, and stature were entered. The InBody 230 displays a visual cue (photo) indicating how and when to hold

the handles during the impedance measure. We registered the following body composition variables: body mass index, skeletal muscle mass, percentage of body fat mass, fat-free mass, total body water and basal metabolic rate.

Prior to the research, parents and their children had been informed about the aim of the experimental study and its procedure. Approval and consent were taken together from the coaches and all respondents of the research.

RESULTS

One of the fundamental anthropometric indexes is human height. Average value for U13 football players is 159.43 cm, U14 – 166.76 cm, and U15 – 174.59 cm. Average value are logically distributed. Variance coefficient (V) and standard deviation values are with similar values. The same is valid for the range of respondents' height.

Table 1. *Respondents' height (cm) descriptive statistics*

	n	X min	Xmax	R	X	S	V	As	Ex
age 13	20	144	178	34	159.43	9.94	6.23	0.256	-0.682
age 14	20	148	178	30	166.76	7.59	4.55	-0.594	0.124
age 15	17	164	194.5	30.5	174.59	7.74	4.44	1.112*	1.541

The other main index revealing anthropometric structure is human weight measured in kg (Table 2). Again, as the data analyzing height here, we see logically distributed data regarding age of respondents. But one thing stands out – the minimum weight measured among players – we register data below 40 kg in age groups U13 and U14, which means some of the players are still in childhood as anthropological development and the training process must be pursuant with this fact. Also, we find higher levels of variety compared to height. From this we can conclude that there are different body structures among respondents.

Table 2. *Respondents' weight (kg) descriptive statistics*

	n	X min	Xmax	R	X	S	V	As	Ex
age 13	20	31.1	65.1	34	45.91	9.56	20.83	0.394	-0.448
age 14	20	39.9	66.2	26.3	53.31	7.91	14.84	0.27	-1.186
age 15	17	48.2	83.3	35.1	62.08	9.01	14.51	0.909	0.86

Body Mass Index is originating from height and weight and bears the marks of their results (see Table 3). The average value ranges from 17.88 (U13) to 20.26 (U15). This is a good standpoint from control of future development of respondents.

Table 3. *Respondents' Body Mass Index descriptive statistics*

	n	X min	Xmax	R	X	S	V	As	Ex
age 13	20	14.6	23.1	8.5	17.88	2.26	12.62	1.051 *	1.177
age 14	20	17	21.8	4.8	19.02	1.58	8.33	0.515	-1.209
age 15	17	17	22.3	5.3	20.265	1.53	7.55	-0.505	-0.38

The InBody system measure some specific indexes as total body volume (measured in liters). This index is with great importance for football. If values are low, we can expect specific traumatism if muscles and tendons and vice versa. The average values must be considered as lower age groups grow up. Also, we would recommend increase of lowest measured values by increasing the volume of water intake.

Table 4. *Respondents' total body water (l) descriptive statistics*

	n	X min	Xmax	R	X	S	V	As	Ex
age 13	20	21.1	42.7	21.6	29.80	6.16	20.65	0.474	-0.662
age 14	20	24.1	44	19.9	35.04	5.69	16.23	0.032	-0.934
age 15	17	31.7	55.5	23.8	41.28	5.96	14.44	0.819	0.829

The other specific indexes measured in this study is body fat mass (kg) which is not very stable index for studied age groups (see Table 5). The main reason for this is that during this period boys enter puberty, and the development of muscles or body mass percentage (Table 6) are strictly individual. We must be very careful with the strength development programs throughout this period and take this fact as investment for future development of football players. This information must be controlled during this age period but not to be taken as mandatory.

Table 5. *Respondents' body fat mass (kg) descriptive statistics*

	n	X min	Xmax	R	X	S	V	As	Ex
age 13	20	2.4	10	7.6	5.345	2.46	46.03	0.719	-0.599
age 14	20	3.04	7.8	4.76	5.557	1.45	26.03	-0.261	-0.946
age 15	17	4	8.6	4.6	5.7941	1.57	27.05	0.449	-1.109

Table 6. *Respondents' percentage of body fat (%) descriptive statistics*

	n	X min	Xmax	R	X	S	V	As	Ex
age 13	20	5.3	20.6	15.3	11.51	4.18	36.37	0.537	-0.136
age 14	20	5.9	17.7	11.8	10.61	3.07	28.94	0.401	-0.013
age 15	17	6.6	13.7	7.1	9.08	2.04	22.42	0.543	-0.268

We find interesting data on Table 7 presenting muscle mass among respondents. Obtained results are more compact compared to data regarding human body fat. As age increase, we find increase in both

average value, maximal and minimal values and also, we can conclude based on variance coefficient and standard deviation that studied groups become more homogenous. Systematic training process aimed at adequate development of physical abilities may have influence on this positive tendency.

Table 7. *Respondents' muscle mass skeletal (kg) descriptive statistics*

	n	X min	Xmax	R	X	S	V	As	Ex
age 13	20	15	32.9	17.9	22.16	5.07	22.87	0.483	-0.618
age 14	20	17.6	34.5	16.9	26.59	4.72	17.76	0.078	-0.907
age 15	17	23.6	43.5	19.9	31.68	4.94	15.59	0.798	0.859

DISCUSSION

This study aimed to investigate the morphological characteristics in three age groups of soccer players of Bulgarian elite academy U-13, U-14, and U-15. We show trends of body height, body weight, body mass index, skeletal muscle mass, percentage of body fat mass, fat-free mass, total body water and metabolic rate of soccer players in one of main age periods for education in sports.

Age period at the beginning of puberty is always hard for conducting adequate training process among young football players. Appling approaches as ours (the use of InBody 270 system) can give us detailed overview of respondents' status and this made on regular times schedule can help identify the level of physical development and from there can optimize training process.

Similar to a study by colleagues in Finland, an interesting trend is found. Vänttinen et al. (2011) manage to establish interesting nuance in the body composition analysis, because it was revealed that peak muscle mass spurt occurred a year later than peak weight spurt did. This was possible because fat mass was reduced because of rapid growth and increased testosterone secretion at the same time as muscle mass was increasing.

Our study has a small sample, but opens up a new path in the world of monitoring and control of anthropometry in football education systems. Studies with a much larger number of elite football players in Bulgaria are needed to increase influence of morphological characteristics in football education.

Obtained data can be a start for further analysis compared to older age group where mode intense training process is led.

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REFERENCES

Cabañas Armesilla, M.D. & Esparza Ros, F. (2009). Compendio de cineantropometria. Madrid: CTO Editorial.

Eston, R., Reilly, T. (2013). *Kinanthropometry and Exercise Physiology Laboratory Manual: Tests, Procedures and Data: Volume Two: Physiology.* Routledge; Oxon, UK.

Leão, C., Camões, M., Clemente, F.M., Nikolaidis, P.T., Lima, R., Bezerra, P., Rosemann, T., Knechtle, B. (2019). Anthropometric Profile of Soccer Players as a Determinant of Position Specificity and Methodological Issues of Body Composition Estimation. *Int. J. Environ. Res. Public Health*, *16*, 2386.

Santos JAR. (1999). Estudo comparativo, fisiológico, antropométrico e motor entre futebolistas de diferente nível competitivo. *Revista Paulista de Educação Física*;13(2):146-59.

Spehnjak, M., Gušić, M., Molnar, S., Baić, M., Andrašić, S., Selimi, M., Mačak, D., Madić, D.M., Žilič Fišer, S., Sporiš, G., Trajković, N. (2021). Body Composition in Elite Soccer Players from Youth to Senior Squad. *Int. J. Environ. Res. Public Health*, *18*, 4982. https://doi.org/10.3390/ijerph18094982

Vänttinen, T., Blomqvist, M., Nyman, K., Häkkinen, K. (2011). Changes in Body Composition, Hormonal Status, and Physical Fitness in 11-, 13-, and 15-Year-Old Finnish Regional Youth Soccer Players During a Two-Year Follow-Up. *Journal of Strength and Conditioning Research*: December - Volume 25 - Issue 12 - p 3342-3351 doi: 10.1519/JSC.0b013e318236d0c2

Zúñiga, U., & De León, L. (2007). Somatotype of semi-professional soccer players classified by their position in the game. *Int. J. Sport Sci,* 3(9), 29-36.

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MODELING OF RUNNING TRAINING IN THE ANNUAL CYCLE FOR ELITE FEMALE TRIPLE JUMPERS

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ABSTRACT
Triple jump is a discipline of the horizontal track and field jumps where one of the factors of the sports achievement is the acceleration speed. A number of authors have studied this indicator, however without taking into account the specifics of running training for women competing in this discipline. The objective of this study is to enrich the theory of running training in highly qualified female triple jump athletes in the annual training cycle. Study tasks: 1) Analysis of the structure and content of Tereza Marinova's annual training cycle in the year of winning the Olympic title. 2) Analysis of the dynamics of running training tools, their inclusion and elimination in individual periods. 3) Creation of a running training model over the annual cycle. Methods: 1) Summary and analysis of the data from the training diary of the study athlete; 2) Mathematical data processing; 3) Sports and pedagogical analysis. Results: 1) The running training of the study athlete starts with an emphasis on developing the aerobic capabilities of the body; 2) The tools used to develop maximum speed reach their highest levels in the pre-competition period, the most used being sections with a length of 40 m.; 3) Various tools are used to develop strength endurance, but the scope of sections with 2.5-5 kg sled at maximum speed has a significant advantage. Conclusion: Taking into account the individuality and preferences of each individual athlete, we believe that the established highlights in Tereza Marinova's training can be used as a guide for building the running training of elite female triple jumpers.

Keywords*: training, triple jump, women*

INTRODUCTION

Already in the 70s of the last century, the problem of periodization and construction of the training process in elite athletes was relevant in the theory and practice. In the recent years, a number of publications have appeared in the methodological literature devoted to the organization of the training process in the annual training cycle of track and field jumpers. There are models developed for load distribution in the various stages of training reflecting the individual characteristics of a number of competitors, as well as studies analyzing the nature and differences in the training load for the different sexes (Miladinov & Yonov, 2001, Vrublevskiy, 2003, Ĉillik et al, 2014). The state and dynamics of the speed and power qualities are the subject of research by a large number of authors (Johnson, 1996, Miladinov & Yonov, 2001). It is an indisputable fact that the take-off speed of the common center of gravity during the rebound in track and field jumping is one of the main factors of sports performance. In order to realize a higher take-off speed of the common center of gravity during the rebound, it is necessary to reach the highest possible running speed during the acceleration (Bachvarov, et al, 1965). Running speed or maximal speed capabilities are of fundamental importance for achieving a high sports result in track and field jumpers (Miladinov, 2019). Therefore, we believe that analyzing the structure and content of running training in the annual cycle of a highly qualified female athlete competing in the triple jump discipline would lead to the achievement of additional knowledge about the theory and practice in the respective discipline.

METHODOLOGY

Objective

The objective of this study is to enrich the theory of running training in highly qualified female triple jump athletes over the annual training cycle. The goal thus set requires the solution of the following tasks, analysis of the structure and content of Tereza Marinova's annual training cycle in the year of winning the Olympic title, tracking and visualization of the dynamics of the relative share of running training tools, their inclusion and exclusion in the individual periods, as well as creating a running training model over the annual cycle.

Research analysis

Research, analysis, and summarization of the study competitor's race log data for a specific period. Sports and pedagogical analysis of the structure and content of running training in the annual cycle. Mathematical processing and graphical representation of the data.

RESULTS

Table 1 represents the analysis of the relative values of the running training tools for the study competitor for the sports competition year 1999/2000 in percentages. The training process started in November, with an emphasis on using tools for speed endurance and laying a foundation for further deployment of the functional capabilities of all organs and systems. The priority in the running training over the special preparation period was to increase the share of the tools for developing maximum speed. The main tools for this were sections with a length of 20-60 m, and the requirement for their implementation changed as the competition period approached. The development of speed and power endurance occurred by using the so-called exercises in difficult conditions, such as running sections of different lengths uphill or pulling a 2.5-5 kg weight sled. The change in the scope of the running training tools used within the annual cycle had a gradual characteristic, with a certain increase or decrease observed in different periods of the year. The tools used in the running training of the competitor analyzed by us could be classified as tools for developing maximum running speed, developing speed, and speed and power endurance. The scope of special running exercises (SRE) is extremely large, from which we can conclude that the study competitor puts a lot of effort in her training on improving the individual details of the running technique while accelerating by the use of these tools.

Table 1. *Relative values of the running training tools over the annual cycle for the sports competition year 1999-2000 (%)*

Months / Tools	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	Total
Sections above 95% intensity													
Sections with a length of 20-60 m				5.57	10.55	8.06	11.67	15.19	9.28	14.89	**17.33**	7.47	**100**
Sections with a length of 100-150 m			5.29		2.64	**27.75**	19.38	13.00		16.96	14.10	0.88	**100**
Sections with 2.5-5 kg sled (m)					21.96	**23.31**	17.57	12.16		12.84	12.16		**100**
Sections uphill (m)			33.33							**66.67**			**100**
Sections below 90% intensity													
Sections with a length of 20-60 m		3.65	**20.55**	13.39	14.33	13.79	7.44	3.25	4.87	6.22	9.26	3.25	**100**
Sections with a length of 100-200 m	5.82	16.59	**19.74**	1.22	13.77	15.30	6.37	1.84	1.84	5.51	11.39	0.61	**100**
Variable running 40-100 m	10.87	23.91			34.78		30.43						**100**
Accelerations	3.14	8.21	10.21	7.77	9.19	**10.72**	8.97	10.50	7.88	7.22	10.07	6.13	**100**
Speed up				14.06				**39.06**	10.94	0.00	12.50	23.44	**100**
High raised knee		**36.65**	14.04		8.58	11.70	3.12	7.02	12.28	4.87	1.75		**100**
Special running exercises (SRE)	1.98	7.46	6.42	6.62	11.47	**12.50**	8.83	10.37	8.16	9.03	11.55	5.62	**100**
Long-distance race	**26.32**	**26.32**			18.42	5.26	7.89	7.89		7.89			100

In Figure 1, we have presented the distribution of the relative values of the training tools for developing maximum speed in the annual cycle. The tools are divided into two categories, those performed with an intensity of more than 95% and those performed with an intensity of less than 90%. The tools used to develop maximum running speed are sections with a length of 20 to 60 m. The logical explanation for this choice is the fact that the 40 m run most closely approximates the length of the speed up in the triple jump. The largest share of training tools with an intensity below 90% is observed already at the beginning of the annual cycle. It is noteworthy that the speed work started in the second mesocycle of the training. The relative values of the tools for developing maximum speed performed with an intensity below 90% reached their highest levels in December (20.55%). In January,

the use of the tools for developing maximum speed with an intensity of over 95% began, with their volume constantly increasing and reaching their highest values during the months when the study athlete was in a pre-competition or competition period. The increased volume of the maximum speed tools in July and August was aimed at creating conditions for entering peak sports shape just in time for the Olympic Games.

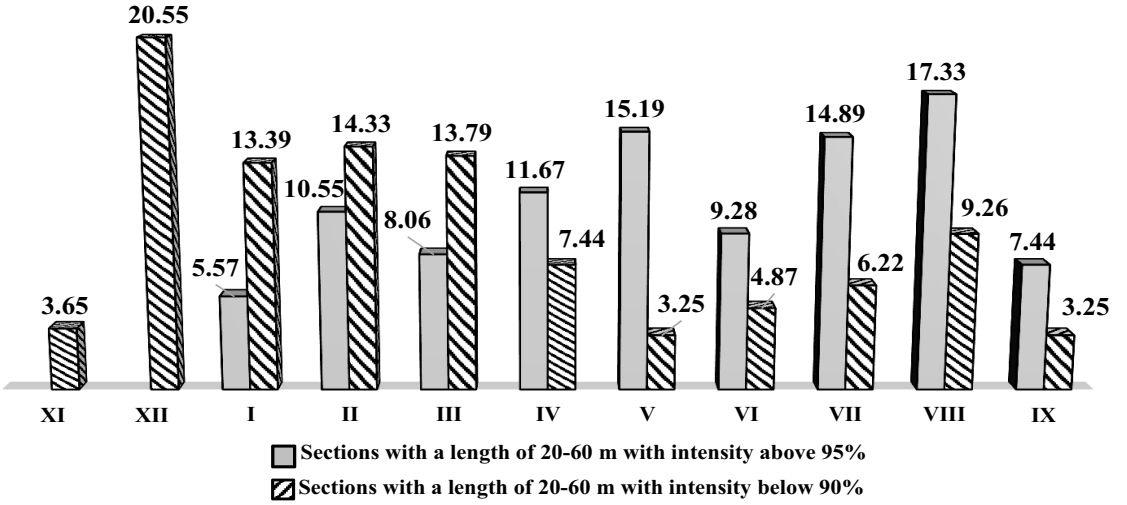

Figure 1. *Dynamics of the relative values of training tools for developing maximum speed in the annual cycle (%)*

Following the dynamics of the relative share of the tools for developing speed endurance, we note the preferential use of sections with a length of 100-150 m (Figure 2).

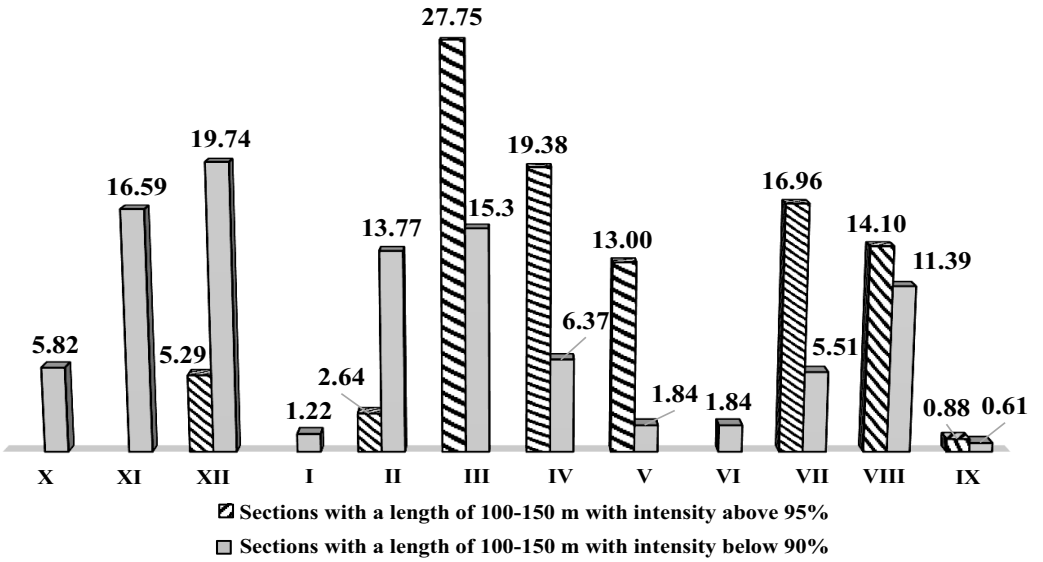

Figure 2. *Dynamics of the relative values of training tools for developing maximum speed in the annual cycle (%)*

At the very beginning of the training, sections with a length of 100-200 m were used, performed with intensity below 90%, with the volume constantly increasing and reaching its maximum values in December, after which it decreased due to the inclusion of tools performed with an intensity above 95%. The length of the sections was reduced to 100-150 m; however, the speed of execution was increased. It should be mentioned that there is a dependence on the inclusion and removal of the tools for developing speed endurance, namely, with an increased share of the methods with 90% intensity, the share of the tools performed with more than 95% is low and vice versa. Regarding the speed

and power endurance, the athlete analyzed by us uses the so-called exercises in difficult conditions, namely running uphill and running sections with a 2.5-5 kg sled.

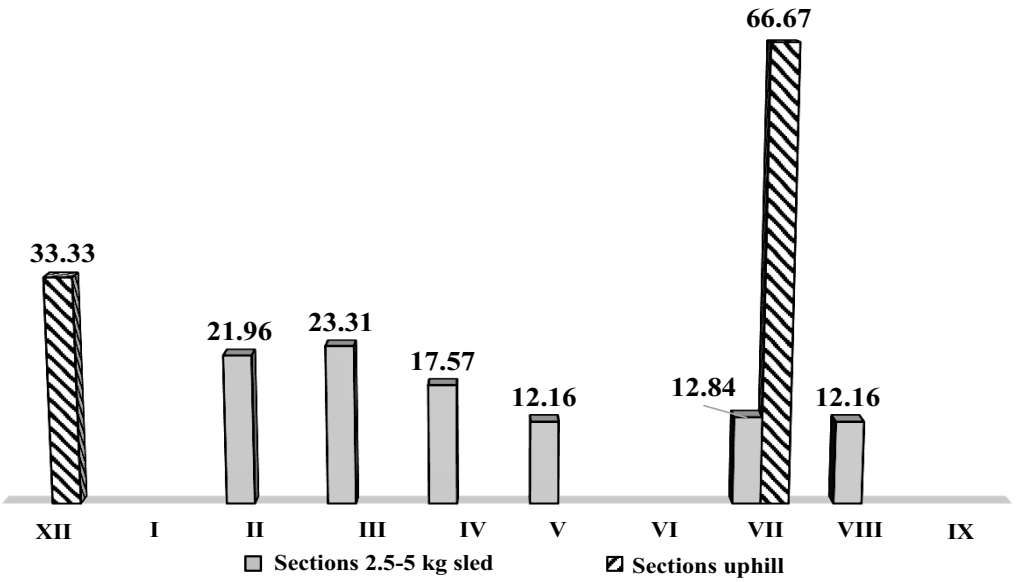

Figure 3. *Dynamics of the relative values of the training tools for developing speed and power endurance in the annual cycle (%)*

Figure 3 shows that uphill running is only used for two months of the annual cycle, and in July the relative share reaches extremely high levels (66.67%). The sections with a sled are based on the method of speed and power endurance and are most prevalent during the second macrocycle of the respective sports competition year. This analysis gave us the reason to derive a model of Tereza Marinova's running training, which would give us a more detailed picture of the implementation of the main training tools in the separate periods of the annual training (Table 2).

Table 2. *Distribution model of the basic tools for Tereza Marinova's running training (BP -Basic preparation, SP-Special preparation, C – Competitive period)*

Macrocycle	**Winter**					**Summer**						
Period	**BP**		**SP**		**C**	**BP**	**SP**	**C**		**SP**		**C**
Months / Tools	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
Sections above 95% intensity												
Sections with a length of 20-60 m				5.57	10.55	8.06	11.67	15.19	9.28	14.89	**17.33**	7.47
Sections with a length of 100-150 m			5.29		2.64	**27.75**	19.38	13.00		16.96	14.10	0.88
Sections with 2.5-5 kg sled (m)					21.96	**23.31**	17.57	12.16		12.84	12.16	
Sections uphill (m)			33.33							**66.67**		
Sections below 95% intensity												
Sections 20-60 m		3.65	**20.55**	13.39	14.33	13.79	7.44	3.25	4.87	6.22	9.26	3.25
Sections 100-200 m		16.59	**19.74**	1.22	13.77	15.30	6.37	1.84	1.84	5.51	11.39	0.61

DISCUSSION

Adequate implementation of training loads, tailored to the individual capabilities of the respective athlete and rational management of the training process are the key to achieving high sports results. A number of authors define the running speed of acceleration as the main factor of the sports performance in athletics jumping, suggesting that an increase in the sports result can be expected due to an increase in the speed of acceleration (Kreer, 1980,

Moura et al., 2005). The running training of the Olympic champion in the triple jump, Tereza Marinova, rests on the observance of a number of principles in the construction of the training process, for example, that the inclusion and elimination of individual training tools in the training process should be carried out step by step (Zhalov, 1977, Miladinov, 2008). For the beginning of the running training of the study athlete, training tools with general effect were chosen, which gradually fell out of the training process and training tools with strictly specialized effect were successively included in their place. The speed was developed almost throughout the entire period of the annual cycle, as the main tool for this were sections with a length of 20-60 m. In a study dated 1977, Zhalov defined a section with a length of 30 m and execution of sections of 30-50 m from a flying start, as the most specific indicators of speed control. In our study athlete, it should be noted that there were no sections performed from a flying start, and the main tool for developing maximum speed was the section with a length of 40 m. The dynamics of the relative values of training tools for developing maximum speed in the annual cycle clearly show that during the first macrocycle those performed with an intensity of less than 90% predominate, and during the second macrocycle, those with more than 95% are predominant. In this regard, we found a difference from the publications of Bauerman & Freeman (1991) that speed develops year-round at 95-98% intensity after an introductory period of 3-4 weeks at a lower intensity. The sections with a length of 100 m are the link between working for maximum speed and speed endurance. And in the work for speed endurance, we found a gradual inclusion and elimination of the various tools, and with an increased share of the tools with 90% intensity, the share of the tools performed with more than 95% is low and vice versa. The development of general and speed endurance of the jumper is the basis of improvement of quickness and increase of running speed, with which we confirm the statement of Miladinov & Yonov (2001). In the second macrocycle, the competition period is characterized by a higher number of competitions. Therefore, the inclusion of an additional special preparation period before the main competition is observed in the running training of the study athlete, with the aim of further increasing the level of training and recovery of the mental energy spent during participation in competitions.

CONCLUSION

In conclusion, taking into account the individuality and preferences of each individual competitor, we believe that the established highlights in Tereza Marinova's training could be used as a guide for building the running training of elite female triple jumpers.

REFERENCES

Bachvarov, D., Zhalov, K. & Kanchev, T. (1965). *Skokovete v lekata atletika*. Meditsina i fizkultura, Sofia.

Bawerman, W. & Freeman, W. (1991). *High-Performance training for track and field*. Leissure Press, Illinois.

Ĉillik, I. & Pupiŝ, M. & Salva, M. (2014). Cumulative Treining Effect in an Annual Trening Cycle of Female Competitors in the Long Jump. *European Journal of Social and Human Science*, № 1, pp. 19-27.

Johnson, C. (1996). The elastic strength development of Jonathan Edwards. *New studies in athletics*, № 2-3, pp.63-69.

Zhalov, K. (1977). *Trenirovkata v troynia skok*, ETsNPK-FKS- Izdatelsko-pechatna baza, Sofia

Kreer, B. (1980). *Troynoy prayzhok*, Fizkultura i sport, Moskva

Miladinov, O.& Yonov, Y. (2001). *Ttrenirovkata v skoka na dalzhina i v troynia skok*, NSA Pres, Sofia.

Miladinov O. & Yonov, Y. (2001). Izsledvane zavisimostta na sportnoto postizhenie ot obema na sredstvata za skorostno-silova podgotovka v skoka na dalzhina v mnogogodishen aspekt. *Sport i nauka*, №3, pp. 3-8.

Miladinov, O. & Yonov, Y. (2008). Iizsledvane ritama na byagane pri zasilvaneto v horizontalnite lekoatleticheski skokove. *Sport i nauka*, № 5, pp.29-33.

Miladinov, O. (2019). *Savremenni aspekti na trenirovkata v lekoatleticheskite skokove*. NSA PRES, Sofia

Moura, N. A., Fernandes T. & Moura P. & Borin J. (2005). Approach speed and performance in the horizontal jumps: What do Brazilian athletes do?, *New studies in athletics*, № 3, pp. 43-48.

Vrublevskiy, E. (2003). Upravlenie trenirovochnym protsessom zhenshtin v skorostno-silovyh vidah legkoy atletiki. *Teoria i praktika fizicheskoy kulytury*, № 6 pp.2-5

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NEURO-MUSCULAR CONTROL OF GYAKO ZUKI FIGHTING TECHNIQUE AS A MEASURE OF SHOTOKAN KARATE ATHLETE'S SKILLS

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ABSTRACT
Specialization in terms of motor skills is perhaps one of the most decisive factors for solving sport-related methodological tasks and achieving victories in modern sports era.
The aim of this study is through a detailed analysis of selected fighting technique (Gyako Zuki) to assess intermuscular coordination, mark specific deficiencies in execution, and thus-avoid training faults and prevent possible injuries occurring with a certain frequency in the upper extremities of Bulgarian Karate fighters.
Methods and methodology of the study:
For this purpose, a kinematic analysis was performed by video registration and subsequent image processing to measure kinematic parameters with a specialized program. A total of 29 Bulgarian Karate Shotokan athletes have taken part in our initial experiment.
The results of our study presented important information for coaches and the practicing Karate Shotokan fighters about the emergence and consistency of muscle synergy contraction patterns while training. This we expect to be useful for a better understanding of available strategies in the execution management of the Karate punch Gyako Zuki and be further developed in the future as even more appropriate training protocols.

Keywords: *Karate Shotokan, kinematic analysis*

INTRODUCTION

Specialization of motor skills is perhaps one of the most relevant factors for solving sports-methodical tasks and achieving victories in the field of modern sports. Establishing and maintaining an adequate muscle contraction pattern and sequence will be essential for achieving symbolic destruction of the opponent through high-speed movements and precision targeting of the opponent's head and body during a karate strike.

The importance of already existing models for muscle synergy between multiple muscle groups improves the simple goal of concentrating maximum force in minimum time in the execution of the chosen Karate fighting technique but also allows for complementary stabilization of the involved joints, balance of the entire kinematic chain (the body of the athlete) and control of the movement in every moment of the execution of the technique. The benefit of simultaneously utilizing the contraction of agonist and antagonist muscles to achieve better control of the movement and to stabilize the involved joint has already been proven, regardless of the disadvantage that they appear to the detriment of motor efficiency (leading to a loss of additional torque in selected joint generated by the agonist). In addition, the co-activation of agonists and antagonists results in increased stiffness and stability of the respective involved joint, with expectedly more pronounced co-activation being performed during the high-velocity movements compared to the low-velocity displacements of Karateka.

Using this thread of initial assessment of the future Karateka and its targeted modeling, we should pay attention to the works of Katic and team, where the synthesis is impressive in the search for predictors of competitive performance and technical performance, by assessing the influence of specific motor abilities in young karatekas, as well as deriving the most successful techniques for this (Katić, 2009). One of the factors brought up was the technical efficiency of a Karateka as determined primarily by his specific ability to develop speed. The factor analysis of Katich's team derived from the main motor variables three significant factors: intermuscular coordination, explosive power, and frequency of movement on the Tatami, while the canonical correlation analysis of the specific area of the Karateka's body (specific mobility) showed that two were most important: a factor of technical mastery and of specific flexibility, with the predominant importance of explosive strength (power), followed by speed and coordination in the execution of hand techniques. The results of this study show that the

effectiveness of any Karate techniques is primarily determined by: explosive power, followed by coordination, i.e. basic motor abilities regulated by cortical mechanisms that are innate. The team's conclusion is specific that these are inherited motor abilities, therefore not dependent on the quality of the training process.

Witte's work is focused on identifying the biomechanical characteristics of the Gyaku-Zuki (backhand executed) Karate technique (Witte, 2005). In Karate, the realization of a powerful technique is related to optimal intermuscular coordination. One aspect of competitive Karate is that in a duel, target accuracy is important for the victory of any particular contestant. According to the Blazevic and Katic team, an effective upper extremity Karate attack by punch requires not only a sufficiently high-velocity movement but also a high quality of motor techniques, making them both essential elements for predicting excellent motor performance (Blazevic, Katic, 2006). For Worrell, the sequence of muscle contraction and intermuscular coordination will play a central role in determining the optimal motor strategy (Worrell, 1998). According to the Japanese team of Hirashima et al., change in any of those parameters can lead to substantial changes in motor strategy and, as a consequence, combat performance (Hirashima, Kadota, Sakurai, et al., 2002). Witte's focus on the results of only six competitors (a small sample, but profiled) with experience in the competitive discipline of Kumite, allowed for the discovery of new knowledge about biomechanical expediency in Karate and the possibility for movement irregularities detection leading to risk for more serious sports injuries. Another research issue was addressed in terms of the possibility of eventual overload of all the involved joints, especially focusing on the very short arm extension time associated with the goal of obtaining greater accelerations. Witte illustrated the overload of the elbow joint and wrist involved in the technique Gyaku-Zuki by high-speed video recording and subsequent measure of the angles reached during the execution, one of his conclusions being that motion in the wrist should not be neglected, as if any joint instability can lead to contact injuries with the opponent.

According to McGill, when observing the execution of fighting techniques by upper or lower extremities, it is noticed that they are usually short-ranged and fast, initiated mainly in the large proximally located joints (McGill, 2010). The Gyaku-Zuki punch can be described as a technique that begins with an initial "burst" of muscle contraction allowing one's fist to be launched forward, although the "punch" itself does not create much impact force upon contact with the opponent's body. But the latter, although resulting in a very quick dissipation of the impulse, is a preparation for the execution of drawing back of the opposite arm, which creates a much greater force of the total impact with a second peak of muscle activation.

The work of the VenacesBrito and Ferreira team in deriving profiled kinematic and electromyographic models of the Gyaku-Zuki punch demonstrated the importance of the "sliding" proximal-to-distal muscle activation of units from the arm and forearm regions during the execution of this specific strike, bringing to the forth the brachial muscle activity with greater intensity compared to the forearm muscles. Of additional value was the correlation: the coordination between agonist and antagonist muscles in the Gyaku-Zuki kick appears to undergo a phasic pattern of reciprocal innervation, such as the amplitudes of muscle activation in Karateka, particularly of axillary flexion and internal rotation, as well as forearm extension and pronation, were lower compared to non-exercisers.

In the field of kinematic analysis of combat techniques, the work of Ning's team aimed to evaluate reaction time (RT), motor time (MT), and total response time (TRT), linking them with the Karate punch Gyako Zuki (left hand), thus eliciting stable patterns of consistent muscle activation during a purposefully chosen fighting technique by the performer, allowing its quantitative and qualitative measurement through the use of surface electromyography (sEMG) (Ning, Yu-Lin, 2010). The experiment confirmed the expected activation of the predominantly left-sided muscles of the upper and lower limbs (the left-sided m. pronator teres, m. triceps brachii, m. deltoideus, m. tibialis anterior, and m. gastrocnemius, but also the right m. tibialis anterior), contracted during the Gyako Zuki technique. Ning confirmed an impressive pattern of muscle contraction corresponding to the expected "proximal-to-distal" sequence of muscle activation inherent to any fighting techniques, starting as a sequence from the left tibialis anterior through the rectus femoris, the left rectus abdominis and ending in the muscles of the left upper limb, represent-

ed by m.deltoideus through m.triceps brachii and m.biceps brachii.

The conclusive results of intermuscular synergy (proximal-to-distal consecutive muscle activation starting from the muscles of the lower limb and propagating to the upper limb) once again prove the importance of creating and maintaining already existing patterns of muscle co-activation favoring the efficient achievement of high velocities and generation of maximum force while engaging the maximum possible muscle units.

Therefore, the high level of motor skills developed through training and related to the objective-focused execution added to the emergence of a rich set of combat-related and technical-tactical variations of a multitude of fighting techniques in a contestant, will be the factors primarily restricting bilateral motor communication in a karate bout - the opponent's ability to "read" an upcoming offensive technique, and countermeasure and devise appropriate counterattack will be greatly affected (Katic, 2005, 2009).

Aim

Through the detailed analysis of a selected fighting technique (Gyako Zuki) to assess intermuscular coordination, mark specific faults in their execution, and thus to avoid errors in training and prevent possible injuries occurring with a certain frequency in the upper limbs in Bulgarian Karate Shotokan athletes.

METHODOLOGY

Kinematic analysis was performed through video recording (with a digital camera Casio ZR 200 with a recording frequency of 120 frames/sec) and subsequent processing of the video image to display the kinematic indicators with a software product (SkilSpector). The sample that participated in our initial experiment was represented by 29 Bulgarian Karate Shotokan athletes (aged from 19 to 29, average 22,3 years old) performing a range of fighting techniques with proven high efficiency in competitions.

Variation and correlation analysis of the results was done with the statistical program package SPSS v.19.

RESULTS

Biomechanical kinematic analysis

Kinematic analysis of the Gyaku-Zuki technique: based on the results derived from the literature on intermuscular synergy from numerous international authors, based on a "proximal-to-distal" sequence of muscle activation, our own experimental setup focused on muscle-initiated contraction analysis emerging from the lower limb, but progressing and enhanced by the muscles of the upper limb, measuring the already established patterns of muscle co-activation in a given fighter, and facilitating the achievement of high execution velocities and the generation of maximum force by engaging the maximum possible muscle units.

Figure 1. *The experimental setup for the executed Gyaku-Zuk hand strike technique;*

In this proximal-to-distal sequence of muscle activation, it was important to reveal the temporal distributions of upper limb movements around the longitudinal axis (such as arm internal rotation and forearm pronation). Our own experiment was beneficial in demonstrating that both peak angular velocities of the movements performed through the longitudinal axis of the segment (arm internal rotation and forearm pronation) were subsequent to the movements performed about the transverse axis (armpit flexion and forearm extension). Additionally, forearm extension reached a greater peak angular velocity relative to forearm flexion, suggesting a peculiar transfer of momentum between the proximal and distal parts of the limb during locomotion.

It is a logical consequence that muscle activation starting with the flexor and internal rotator muscles of the arm will reach its peak before contact and, accordingly, before reaching the peak angular velocity of the arm flexion and internal rotation. Additional finding is that the muscles antagonistic to the movements in the upper extremity (and mainly responsible for forearm extension) as well as forearm pronation (m. pronator teres) presented a peak of muscle activation just before contact with an opponent. In forearm movements, a temporal relation was found between the instant of peak angular velocity and the moment of peak activity of the agonist group, possibly due to the influence that arm acceleration has on forearm acceleration. Here, Zehr and Baratta's observations overlap with our own findings—synchronized contraction of agonist and antagonist muscles leads to better movement control while stabilizing the involved joints, and is necessary during high-velocity execution of fighting technique (Zehr, 1997; Baratta, 1988). The first period of activation of the forearm flexors (m.biceps brachii, m.brachioradialis) and pronators (m. pronator teres) can be deduced as important for elbow stabilization, preparing the forearm for the subsequent acceleration. The observed faster m.deltoideus (pars spinata) activation would be a skill leading to both faster transfer of acceleration/velocity to the distal segment (forearm and fist) by purposefully slowing down the velocity of the proximal segment (arm) and with a favorable effect on the force of the Gyaku-zuki straight punch.

It is worth noting that the peak angular velocity of the movements performed around the longitudinal axis of the segment (arm internal rotation and forearm pronation) occur later than the movements performed around the transverse axis (arm flexion and forearm extension). Therefore, muscle activation, beginning with the group of arm flexors and internal rotators, will preside their peak before contact, and before the reach of peak angular velocity of arm flexion and internal rotation, respectively. Compared to them, the antagonist muscles in the upper arm and those mainly responsible for forearm extension presented their peak of activity before contact, and finally, in the last milliseconds preceding the moment of contact, the activation of the antagonists-forearm extensors, as well as the pronator teres, completed its activation peak just before contact.

The detailed kinematic model based on muscle co-activation during the performance of Gyaku-zuki by Bulgarian Karate athletes confirmed that the first activated muscles are the agonists of arm flexion and internal rotation (m.deltoideus: pars clavicularis), in the initial phase of contraction, parallel to the primary activation of the forearm flexors and pronators (m.biceps brachii, m.brachioradialis, and m.pronator teres). The activation of the forearm extensors (m.triceps brachii) reaches 40% (104 ms) of the total time for making contact with the opponents body, paralleled by the secondary activation of the forearm pronator (m.pronator teres). During the analysis of antagonistic activity of the involved muscles, the following made an impression: the arm internal rotation and flexion performed by m.deltoideus (p.spinata), respectively, varied from 67% (49 ms) to 50% (72 ms) of the time before contact, i.e. is approximately 40% delayed relative to activation of the arm agonists. The last muscle groups activated in the Gyaku-zuki strike will be the forearm extensors and pronators, alongside their antagonists (m.biceps brachii, m.brachioradialis). As for the peak muscle contraction for arm flexion and internal rotation from m.deltoideus (p. clavicularis), they are reached consecutively in 33% (97ms) and 40% (102ms) of the time before contact with the opponent. However, in the muscles antagonistic to this movement (m.infraspinatus and m.deltoideus: p.spinata) it appeared more near contact from 20 (29ms) to 10% (14ms) before impact, respectively. The ability to induce higher activation of the m.deltoideus (p. spinata), will be a mechanism to transfer acceleration/speed to the end parts of the upper limb by decelerating the speed of the nearby segment, favorably affecting Gyaku-zuki strength.

Considering the behavior of the muscles involved in forearm extension and pronation, m.triceps brachii appears with one of the highest activation intensities, projecting almost 100% of its work-load capacity, yet the second activation of m.pronator teres presents an even higher peak in intensity. In the antagonistic muscles (m.biceps brachii, m.brachioradialis), the reached intensity is less than 50% of their optimal work-load capacity while performing the Gyaku-zuki technique. In the forearm movements, the expected temporal overlap between the moment of reached peak angular velocity and the moment of peak activity of the agonist group was confirmed, possibly due to the added influence of arm acceleration leading to synchronized acceleration of the forearm by their own and arm muscles.

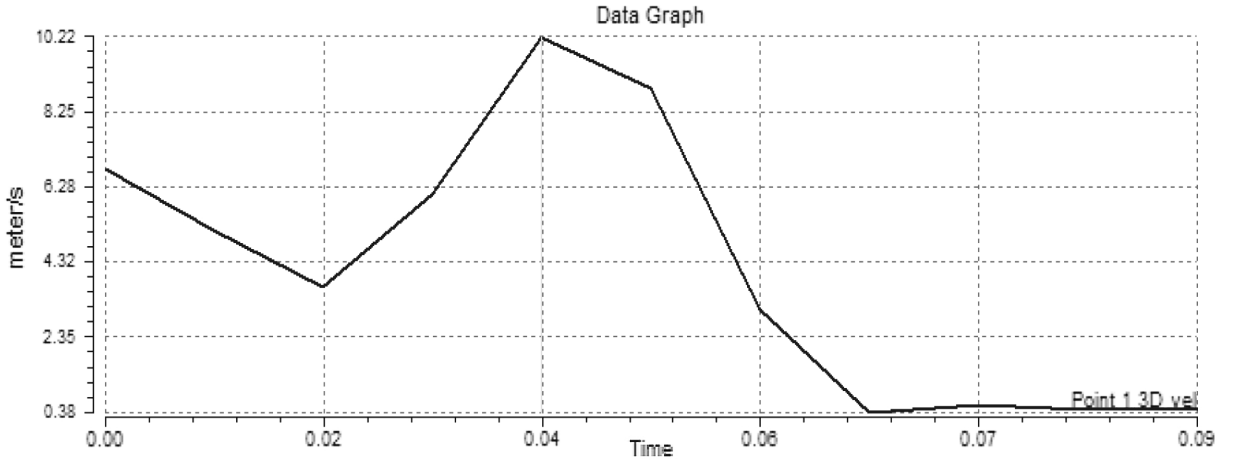

Figure 2. *Graphic representation of the acceleration of 2 selected points of the upper extremity: shoulder joint and fist, at the performance of the Gyaku-zuki technique;*

Within our own experiments, we derived an average velocity of hand strike measured at 13.2 m/s, with a range of variation within the Karate fighters sample from 5.1 m/s to 21,2 m/s. These values do not differ from the trials of Gianino, in whose experiment the effective terminal velocity of the fist before contact was also 13 m/s, with the terminal acceleration of the forearm and fist having a uniform acceleration of 63 m/s (Gianino, 2010). The indicated values according to the literature review are within the limits of our own measurements, and confirm that the mentioned "proximal-to-distal" activation of multiple muscle groups from the lower limb, torso, and ending in the striking upper extremity provide not only the condition for applying effective force but also achieving the necessary acceleration/terminal velocity to execute a successful hand strike attack without countermeasures from the opponent. Again, it is striking that within the group of Bulgarian Karate fighters, there is an almost fourfold difference in the reached velocities by the inexperienced fighters with only 1-2 years of experience, compared to the most skilled among the black belts athletes (with greater fight experience), once again emphasizing the effective control of the body and the execution of techniques successful in terms of speed and strength by the athletes with a longer and more successful competitive career.

Table 1. *Average Speed Values in performing Gyaku-Zuki hand strike*

Individual technique	V Gyaku-Zuki
X	13.2
S	3.6
V	27%
As	-0.1
Ex	0.6
Max	21.2
Min	5.1
R	16.1

Additionally, our own research found that for punches even if the average Gyaku-Zuki velocity was 13.2 m/s (with a range of variation of 5.1 to 20.1 m/s) as expected - the highest values being 16.1 m/s and beyond were presented precisely by our high-ranking contestants, and mostly among first-dan specialists. Also, we observed that the highest number of competitors are those of first dan when screening for an average Gyaku-Zuki velocity within 14 m/s range (from 9.9 to 21.2 m/s) for Bulgarian black belts, where compared to lower extremity fight techniques (kicks) the front kick marked a 33% drop in average Mae-Geri terminal velocity, while it is lowest in the Yoko-Geri kick, where the average execution speed (9.5 m/s) was almost equal to the lowest execution speed of the Gyaku-Zuki punch.

Table 2. *Average values of upper extremity impact velocity in elite athletes and lower ranks;*

Elite	**V Gyaku-Zuki**	Nationals	**V Gyaku-Zuki**
average	14.0	average	10.4
max	21.2	Max	17.0
min	9.9	Min	5.1

After the analysis, several dependencies are noticeable: Gyaku-Zuki is the combat technique creating the most heterogeneous group in black belts, yet with the highest absolute values in terms of speed, a factor we have already paid attention to, where from the slowest to the fastest in terms of speed, the difference is over 2 times.

Compared to our elite Belts of I and II Dan, 3rd and below kyu Karate fighters, who took part in our study, the results were expectedly in lower range: lower averages were observed most pronounced in the drop of 30% to 10.4 m/ s for Gyaku-Zuki technique, with a pronounced leveling in the average execution speed of hand blows and leg kicks, with lower maximal values and higher minimal values of the studied sample, which is completely understandable from the point of view of the qualification level. Here a vivid impression is made, while comparing our most representative and effective in competition hand technique Gyaku-Zuki, where speed vary from slowest to fastest fighters of already 3.4 times - even on its own this is a huge difference. Those numbers point towards Gyaku-zuki as a technique to represent the measure of muscle utilization after action signal, which can allow not only to look for performance imperfections in the less prepared, but even to highlight the athletes with a greater potential for a quick attack/effective counterattack.

Using the values obtained within the framework of our experiment, an expected model can be created from the execution velocities of each prospective player, with subsequent monitoring of the applied changes in response to the training regime, and the evaluation of change in the reached speeds of this indicative of the technical level and capabilities of the Karate players combat technique.

DISCUSSION

The presented results provided important information for coaches and practicing fighters: the Gyaku-Zuki technique is precisely the one that stands out from the point of view for predicting the technical capabilities of our Karate fighters. Among our moderately profiled competitors (1-3 kyu), Gyaku-Zuki was also the combat technique with the largest intra-group variations in the speed of its execution, as the fastest performing competitors will be precisely the most promising in terms of future development. For our elite Karate athletes, Gyaku-Zuki is a measure of the stability of the muscle synergy patterns achieved during the contraction of the already trained muscle groups. Any deviation from the expected and optimal values of this fighting technique in Karate will signal the need for additional training, which in turn, we expect, will be useful for coaches to better understand the effectiveness of the available applied strategies in the motor control of Gyaku-Zuki punch and for the further development of even more effective training protocols in the future.

REFERENCES

Alexander, R.M. (1991). Optimum timing of muscle activation for simple models of throwing, *J Theor Biol* 150:349–372

Anson J. G., Mawston G. A. (2000). Patterns of muscle activation in simple reaction time tests. In Weeks D. J.,

Chuo R., Elliott D. (Eds.), *Perceptual motor behavior in Down syndrome.* Champaign, IL: Human Kinetics. Pp. 46–67.

Baratta, et al. (1988). Muscular coactivation. The role of the antagonist musculature in maintaining knee stability, *Am J Sports Med* 16:113–122

Blazevic, et al. (2006). The effect of motor abilities on karate performance, *Coll Antropol* 30:327–333

Chowdhary, A.G., Challis, J.H. (1999). Timing accuracy in human throwing, *J Theor Biol* 201:219–229

Chowdhary, A.G., Challis, J.H. (2001). The biomechanics of an overarm throwing task: A simulation model examination of optimal timing of muscle activations, *J Theor Biol* 211:39–53

Gianino, C. (2010). Physics of Karate. Kinematics analysis of karate techniques by a digital movie camera. *Am. J. Phys. Educ*. Vol. 4, No. 1, Jan. 2010

Hirashima, et al. (2002). Sequential muscle activity and its functional role in the upper extremity and trunk during overarm throwing, *J Sport Sci* 20:301–310

Katic, et al. (2005). Morphological structures of elite Karateka and their impact on technical and fighting efficiency, *Coll Antropol* 29:79–84

Katic, et al. (2009). The impact of specific motoricity on karate performance in young karateka, *Coll Antropol* 33:123–130

McGill, et al. (2010). Evidence of a double peak in muscle activation to enhance strike speed and force: an example with elite mixed martial arts fighters. *J Strength Cond Res*. 2010 Feb;24(2):348-57

Ning Yu-Lin, et al. (2011). Patterns and Consistency of Muscle Recruitment for a Karate jab TAIWAN. *Biomedical Engineering: Applications, Basis and Communications*, Vol. 23, No. 1 75–82.

Sbriccoli, et al. (2010). Neuromuscular control adaptations in elite athletes: The case of top level karateka, *Eur J Appl Physiol* 108:1269–1280

VencesBrito, A.M., Rodrigues Ferreira, M.A., Cortes, N., Fernandes, O., Pezarat-Correia, P. (2011). Kinematic and electromyographic analyses of a karate punch. *J Electromyogr Kinesiol.* Dec;21(6):1023-9. doi: 10.1016/j.jelekin.2011.09.007. Epub 2011 Oct 17. PMID: 22005009.

Witte, K. et al. (2005). *Biomechanical measuring stations to solve practical problems in karate sport.* Department of Sport Science, Otto-von-Guericke-Universität Magdeburg, Germany

Worrell, et al. (1998). Electromyographic reliability and analysis of selected lower extremity muscles during lateral step-up conditions, *J Athl Train* 33:156–162

Zehr, E.P. et al. (1997). Ballistic movement performance in karate athletes, *Med Sci Sport Exer* 29:1366–1373

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CORRELATION BETWEEN CONTROL TEST TIMES RELATED TO THE ANAEROBIC THRESHOLD DETERMINED BY THE X-METHOD IN ROWERS

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ABSTRACT
Aim: The aim of the study is to investigate the correlation between the times for overcoming the distance of 2000 m achieved in control tests on the water and the anaerobic threshold determined by the X-method in laboratory conditions.
Material and Methods: Includes collection and analysis of the times achieved in overcoming the distance of 2000 m and the anaerobic threshold determined by the X-method, related to the individual ergometric power and heart rate for each participant. Five elite rowers from the National Team of Bulgaria, men, for the period from 2018 to 2021 were examined. To determine the anaerobic threshold by the X-method, we used the data from minute pulmonary ventilation and heart rate recorded every 20 s during the maximum spiroergometric test with increasing intensity. The test was performed on a Concept II rowing machine and equipment measuring pulmonary ventilation and heart rate.
Results: The Pearson coefficient r = .457 (α = .05) shows a moderate correlation between the times for overcoming the distance of 2000 m, and the heart rate recorded at the anaerobic threshold determined by the X-method.
Conclusion: The X-method for determining the anaerobic threshold is an relevant method in the control of the training process and has prognostic value in determining the functional status of rowers. An advantage is the significantly lower cost of the used diagnostic equipment compared to the cost of a conventional gas analyzer.

Keywords*: anaerobic threshold; rowing; X-method; minute pulmonary ventilation; heart rate*

INTRODUCTION

Laboratory control tests on rowers in Bulgaria began in 1968 with the research of Prof. I. Iliev. The purpose of such tests is to present the current functional state of the athlete, to observe the state of the cardiovascular and respiratory systems as a result of the training process, and to determine the mechanical performance achieved on a rowing machine. Some sports experts compare the results of laboratory tests with sports attainment (Bentley, 2007). In endurance sports, such as rowing, there are two basic criteria for determining the functional condition of the athlete. One criterion is the maximal oxygen consumption (VO_{2max}) achieved during a maximal exercise test with increasing intensity. The measurement of VO_{2max} of paddlers is not the only possible determinant of performance and the anaerobic aspects should not be overlooked (Daniel, 2017). Since VO_{2max} is not always related to better competitive performance, the development of sports science suggests that the anaerobic threshold should be such a criterion (Allen, 1985; Bishop, 1998; Bosquet, 2002; Ghosh, 2004). There are many methods for its determination in sports practice, differing in their reliability, accuracy, difficulty in applying, cost and complexity of the equipment used, and their invasiveness Bindera, 2008). Predicting sports results is of logical interest to athletes and coaches. For this purpose, field tests determining critical speed or power are used, which are related to sports achievements (Bosquet, 2002). Thus, the comparison between control field tests and the heart rate reached at the anaerobic threshold (AnT) during a maximal exercuse test with increasing intensity conducted on a rowing machine could be used to better predictor of performance in rowers.

Recently, the X-method (Stefanov, 2021) for the determination of AnT was published, which is non-invasive, accurate and relatively easy to apply in rowers, compared to other reference methods (Stefanov, 2022).

The aim of the study is to investigate the correlation between the times for overcoming the distance of 2000 m achieved in control tests on the water and the anaerobic threshold determined by the X-method in laboratory conditions.

MATERIAL AND METHODS

Includes collection and analysis of the times achieved in overcoming the distance of 2000 m

and the anaerobic threshold determined by the X-method, related to the individual ergometric power and heart rate (HR) for each participant. Five elite rowers from the National Team of Bulgaria, men, for the period from 2018 to 2021 were examined. To determine the anaerobic threshold by the X-method, we used the data from minute pulmonary ventilation (V_E) and heart rate. Measurements were performed bred-by-bred and averaged every 20 s during the maximal spiroergometric test with increasing intensity. The test was performed on a Concept II rowing machine and equipment measuring pulmonary ventilation and heart rate - spirometry system Cosmed Quark CPET.

Procedure

At the beginning of the laboratory test, the anthropometric indicators of the competitors are measured and familiarized with the possible adverse consequences for them during its completion. They are familiarized with the conditions and devices for conducting the research. To determine AnT, W, HR, and V_E are measured. The initial load intensity is 60 Watt. Each step lasts 2 min. Each subsequent stage is 40 Watt higher than the previous one.

AnT was determined according to the X-method described recently (Stefanov, 2021). The method uses the intersection point between the curve reflecting the difference (Diff) and the curve reflecting $\%V_E$ (Figure 1). Diff is the difference between the percentage of heart rate reached (%HR) and the percentage of pulmonary ventilation ($\%V_E$). %HR is defined relative to peak heart rate (HR_{peak}), and $\%V_E$ relative to peak pulmonary ventilation (V_{Epeak}). The abbreviation „V_E“ is an alternative to „Ve“. As can be seen from Figure 1 on the abscissa is plotted the power with which the participant performs during the test, and the intersection point between the curves corresponds to a precisely determined value. It is important to follow exactly the way of scaling described by the authors to preserve the proportion of HR and V_E. By plotting heart rate versus power in Figure 2 we define HR corresponding to AnT.

Tests on water are conducted at a distance of 2000 m.

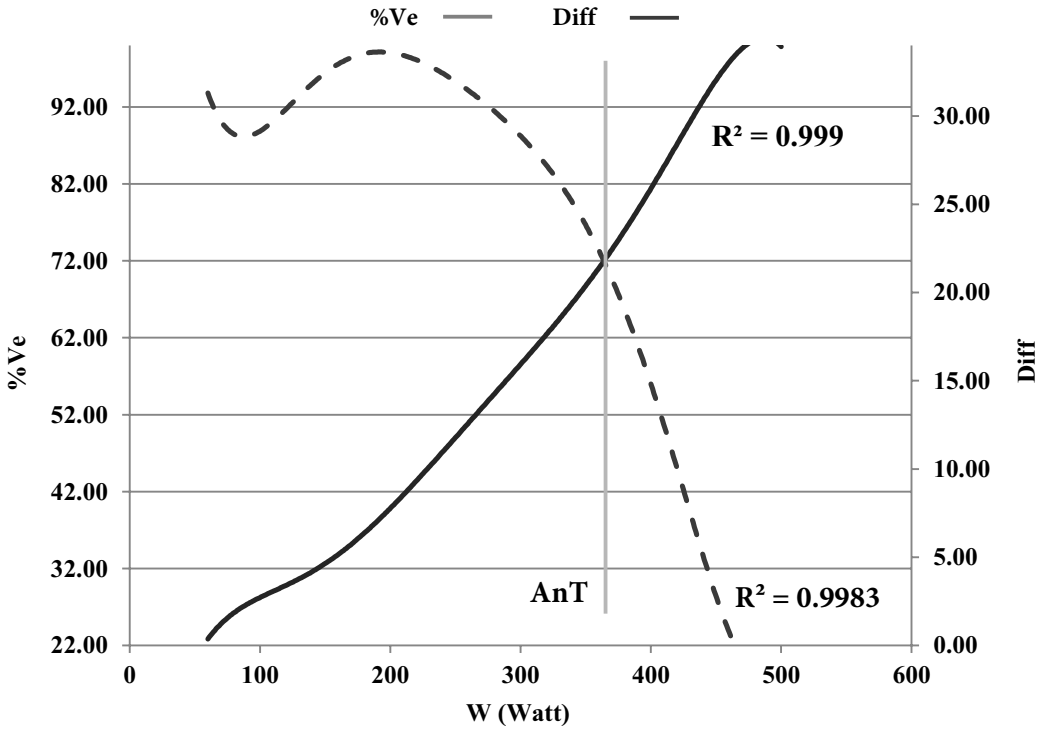

Figure 1. *Example of application of the X-method in determining AnT*

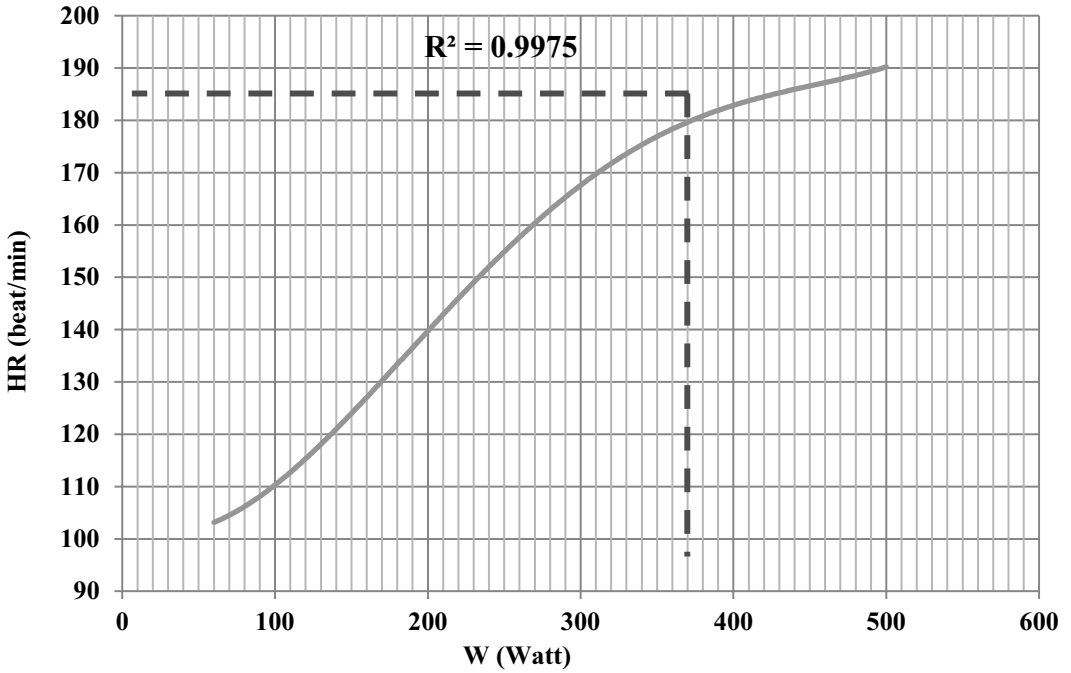

Figure 2. *Represents the changes in heart rate versus power output at any time during the test*

RESULTS

In the first column of Table 1, the initials of each athlete and the time of the test (t2000) are presented. The following columns present the power values at which AnT was detected (W_ AnT) and the HR value at which AnT was determined (HR_ AnT). The percentage of peak heart rate at which AnT was detected (AnT %HR_{peak}) is also presented.

Table 1. *Represents the AnT for each athlete from each laboratory test relative to the time to cover 2000 m on water.*

Name	W_ AnT (Watt)	HR_ AnT	AnT %HRpeak	t 2000 (s)
HS18	300	174	92.6	369.6
HS19	285	172	91.0	365.1
HS20	274	169	89.9	364.4
HS21	292	167	90.3	363.1
PL18	294	195	96.1	399.2
PL19	308	195	97.5	398.3
PL20	317	188	94.9	388.4
PL21	300	187	94.0	383.2
VK18	366	189	96.4	357.5
VK19	352	182	92.4	356.1
VK20	379	182	93.8	355.5
VK21	369	185	95.4	416.3
JB18	324	155	82.4	374.7
JB19	312	157	89.7	360.9
JB20	313	159	87.4	362.2
JB21	315	164	93.2	364.1
NE18	222	163	85.3	382.9
NE19	324	189	92.2	374.3
NE20	326	183	88.8	375.3
NE21	307	179	85.6	368.3

Table 2. *Presents the number of observations, the means and standard deviations of the variables, the coefficient of variation V and p-values from the Lillienfors normality test*

Variable	Obs.	Mean	Std. dev.	V	Lilliefors - p
W_ AnT (Watt)	20	314.0	35.6	11.3	0.15
HR_ AnT	20	176.7	12.7	7.2	0.19
AnT %HRpeak	20	91.4	4.0	4.4	0.59
t 2000 (s)	20	374.0	16.3	4.4	0.15

The coefficient of variation (V) shows that the samples are relatively homogeneous, which is probably due to the similarity in the physical capabilities of the athletes, the appropriate control of the training process and the strict implementation of the test methodology. The Lillienfors normality test shows that all p-values are greater than $\alpha = .05$, therefore the samples have a normal distribution.

Table 3. *Presents the correlation matrix of the Pearson correlation coefficient and p-value for each variable.*

Variables	W_ AnT (Watt)	HR_ AnT	AnT %HR_{peak}	t 2000 (s)
W_ AnT (Watt)	**1**	0.351	0.400	-0.084
p-values	**0**	0.129	0.080	0.724
HR_ AnT	0.351	**1**	**0.754**	**0.457**
p-values	0.129	0	0.000	0.043
AnT %HR_{peak}	0.400	**0.754**	**1**	0.326
p-values	0.080	**0.000**	**0**	0.161
t 2000 (s)	-0.084	**0.457**	0.326	**1**
p-values	0.724	**0.043**	0.161	**0**

The Pearson correlation coefficient (Table 3) shows a moderate correlation $r = .457$ ($\alpha = .05$) between the times to overcome the distance of 2000 m and the heart rate recorded at the anaerobic threshold determined by the X-method. In the same table, the large correlation between AnT %HR_{peak} and HR_ AnT impresses - $r = .754$ ($\alpha = .05$).

The coefficient of determination (Table 4) shows that 20.9% of the variation of t2000 can be explained by the variation of HR_ AnT. 56.8% of the variation in HR_ AnT could be explained by the variation in AnT %HR_{peak}.

Table 4. *Presents Coefficients of determination (R^2)*

Variables	W_ AnT (Watt)	HR_ AnT	AnT %HR_{peak}	t 2000 (s)
W_ AnT (Watt)	**1**	0.123	0.160	0.007
HR_ AnT	0.123	**1**	0.568	0.209
AnT %HR_{peak}	0.160	0.568	**1**	0.106
t 2000 (s)	0.007	0.209	0.106	**1**

DISCUSSION

The analysis of the results of our study show that the observed samples are relatively uniform and have a normal distribution, which allows us to use the parametric methods of statistical analysis. The moderate correlation between HR_ AnT and t2000 shows that the laboratory determination of AnT by the X-method can explain the achieved sports results in 20.9 %. The high correlation between AnT%HR_{peak} and HR_ AnT is expected since both variables are related to heart rate. It is normal for heart rate at AnT to be highly correlated with the percentage of peak heart rate at which AnT registers. This is also explained by the fact that the maximum heart rate (HR_{max}) is strictly individual for everyone, depending on their age.

From Table 1, the column t2000 shows that with each subsequent test the time to cover the distance of 2000 m is shortened. Don McKenzie, (2019) assume that a 1–2% increase in power output from one competition season to the next is required to improve medal perspective in kayak racing (Don McKenzie, 2019).

From Table 1, column AT%HR_{peak} shows that AnT expressed as a percentage of HR_{peak} varies between 82.4% and 96.4%. Similar results have been reported by other authors. Lactate threshold corresponds to 89.6% of HR_{max} and 82.4% of peak VO_2 (van Someren, 2001). Jones et al. (2019) state that usually AnT is at 75 – 90% of VO_{2max} (Jones, 2019). Laurent Bosquet (2002) reported that thresholds determined using different techniques but the same data sets varied between 79 and 92% of VO_{2max} (Bosquet, 2002). Santos & Giannella-Neto found AnT at 88% of VO_{2max} (Santos, 2004). Pühringer et al. found VT2 at 83 ± 10% of VO_{2peak} (Pühringer, 2020).

CONCLUSION

Determination of AnT by the X-method in laboratory conditions, through a maximal exercise test with increasing intensity in rowers can improve the prediction of the time to cover 2000 m. This method together with other established functional indicators guiding the training process can improve the prediction of sports achievement.

We recommend that similar studies be conducted with a larger cohort, if possible, and those mathematical models are developed describing the correlations we have established.

REFERENCES

Allen, W.K., Seals, D.R., Hurley, B.F., Ehsani, A.A.and Hagberg, J.M. (1985). Lactate threshold and distance running performance in young and older endurance athletes. *J. Appl. Physiol.* 58: 1281-1284.

Bindera, R.K., Wonischb, M., Corrac, U., Cohen-Solald, A., Vanheese, L., Sanera, H. et al. (2008). Methodological approach to the first and second lactate threshold in incremental cardiopulmonary exercise testing. *European Journal of Cardiovascular Prevention and Rehabilitation*. 15:726–734.

Bishop, D., Jenkins, D.G. and Mackinnon, L.T. (1998). The relationship between plasma lactate parameters, Wpeak and 1-h cycling performance in women. *Med. Sci. Sports Exer.* 30: 1270-1275.

Bosquet, L., Léger, L., Legros, P. (2002). Methods to Determine Aerobic Endurance. *Sports Med*. 32 (11): 675-700.

López-Plaza, D., Alacid, F., Muyor, J.M., Miñarro, P.A.L. (2017). Differences in Anthropometry, Biological Age and Physical Fitness Between Elite Kayakers and Canoeists. *Journal of Human Kinetics*, 57, 181-190.

Bentley, D.J., Newell, J., § Bishop, D. (2007). Incremental Exercise Test Design and Analysis Implications for Performance Diagnostics in Endurance Athletes. *Sports Med* 37 (7): 575-586.

McKenzie, D., Berglund, B. (2019). *Handbook of Sports Medicine and Science. Canoeing.* Wiley-Blackwell, ISBN 9781119097211

Ghosh, A.K. (2004). Anaerobic Threshold: Its Concepts and Role in Endurance Sport. *Malaysian Journal of Medical Sciences*. 11 (1):24-36)

Jones, A.M., Burnley, M., Black, M.I., Poole, D.C., Vanhatalo, A. (2019). The maximal metabolic steady state: redefining the 'gold standard' *Physiol Rep.* 7 (10).

Pühringer, M., Ring-Dimitriou, S., Stöggl, T., Iglseder, B., Paulweber, B. (2020). Comparison of visual, automatic and semiautomatic methods to determine ventilatory indices in 50 to 60 years old adults. *Journal of Sports Sciences*. 38:6, 692-702.

Santos, E.L., Giannella-Neto, A. (2004). Comparison of computerized methods for detecting the ventilatory thresholds. *Eur J Appl Physiol*. 93: 315–324.

Stefanov, L.G., Nejkov, S.E. (2021). Determination of Anaerobic Threshold by a new approach through the incremental exercise using proportion in heart rate and pulmonary ventilation changes in rowers. *Pedagogy of Physical Culture and Sports* 25(2):89-97.

Stefanov, L.G. (2022). Comparison between determination of second anaerobic threshold by respiratory compensating point and X-method in rowers. *Pedagogy of Physical Culture and Sports* 26(2):112–121.

van Someren, K.A. and Oliver, J.E. (2001). The efficacy of ergometry determined heart rates of flatwater kayak training. *International Journal of Sports Medicine* 23, 28-32.

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OBJECTIFICATION OF THE RELIABILITY AND STABILITY OF BALANCE ACROBATIC EXERCISES PERFORMING

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ABSTRACT
Introduction. The "reliability" and "stability" as terms are related to technical preparation in sports with a stable kinematic structure. According to the hypothesis of this study, the objectification of the reliability and stability of balance acrobatic exercises through biomechanical analysis will allow collecting information not only about the technique of the studied exercise, but also about the level of motor habit and psycho-physiological characteristics of the performer. This will help to improve the training methodology and increase the competitive realization of the athlete.
Method. The research was carried out with the help of Bertec Force Plates that can be digitally integrated with the myo FORCE software module. The object of study is a basic individual acrobatic exercise – hand standing. It was performed by an athlete aged 22 years. 25 repetitions of the studied exercise were performed with an interval between them of 2-3 minutes. The subject of the study is biomechanical parameters in key positions such as linear, angular and velocity characteristics, Contact force (N), fluctuation of Gravity center, the dynamics of the positive, negative, and borderline attempts, and others.
Results. The collected data were statistically processed. A comparative analysis of the studied attempts performed in one training session was performed. The study proved that 17 repetitions were positive, 6 negative, and 2 borderlines. In percentage, this ratio is 56: 32:12. A long series of 6 consecutive positive attempts was found in the second half of the experiment.
Conclusion. Based on the data collected in this study, it can be concluded that the researched athlete achieves peak reliability and stability when performing an individual balance exercise with small difficulty after 10 repetitions. This finding can be taken into account when preparing the athlete to participate in a competition through adjustments in the special warm-up.

Keywords: *reliability, stability, balance acrobatic exercises, technical preparation, biomechanical analysis*

INTRODUCTION

Technical preparation in sports with programmed movements and a stable kinematic structure, such as those of the gymnastics family, is particularly important for achieving high results. Reliability and stability when performing gymnastic and acrobatic exercises are among the main goals and tasks of this type of preparation. In theory, often the concepts of "reliability" and "stability" are used together as a phrase. Essentially, each of these two terms has an independent meaning. Reliability is related to technical precision in performing exercises, while stability is determined by the ratio of successful to unsuccessful repeats in a training or competition session. Another characteristic feature of stability is its connection not only with technical accuracy but also with the level of motor habit.

According to the hypothesis of this research, the use of scientific methods to determine the parameters of reliability and stability during the performance of acrobatic exercises will allow a complete collection of information about the technique of the studied exercise, the level of the motor habit and the psycho-physiological features of the performer. Comparing a series of repetitions of a given exercise in a training session on the basis of objective data from the biomechanical analysis will help to conclude the technical precision and stability of the motor habit. This would contribute to improving the training methodology, optimizing the technical preparation, and increasing the opportunities for the athlete's competitive performance. In this regard, this research aims to determine the reliability and stability level when performing balance acrobatic exercises using a comparative biomechanical analysis.

In this regard, the object of the research is multiple repetitions in one training session of a basic individual balance acrobatic exercise – swinging up to a handstand.

The literature review revealed Philip Filev's book (1976) aroused interest. The author examines the issues of the "reliability" of gymnastic exercises. The book can be defined as the primary source of systematized information on this problem in Bulgarian sports literature. Filev examines the reliabil-

ity issue in artistic gymnastics based on a general theoretical statement of the problem, a definition of the concept from several points of view, and applying mathematical formulas to objectify the issue under consideration. The papers of other world-famous experts such as Bernstein (1966), Gambarian (1967), Donskoi (1969), Dyachkov (1967), Korenberg (1970), Sorin (1969), Ukran (1971), Luebbert (1956), Chorafas (1963) and others were studied.

The author of the present work has previous researches in this field, examining the reliability and stability of performing the competitive series in tumbling gymnastics (Angelov, 2010). The identified gap in the reviewed literature, regarding the reliability and stability of balance gymnastics exercises, motivated the authors of this article to realize this study.

METHOD

The study was carried out using a specialized platform "Bertec Force Plates" which was digitally integrated with a software module "Myo FORCE" using an AM6800 amplifier. Two cameras are included in the research kit, which records the studied exercise from two positions - in profile and frontal. During video recording, the cameras are stationary, their optical axis is perpendicular to the subject, and the zoom lenses are in the same position. In addition, scientific and research methods such as video recording, video cyclography, comparative biomechanical analysis, expert assessment, pedagogical observation, statistical methods, etc., have been applied. A 22-year-old athlete performed the studied exercise with many years of competitive experience in sports acrobatics as the top partner in the men's pair. The participant studied has signed an informed agreement that the information received from the research will be used in the present survey. After a preliminary warm-up, 25 repeats of the exercise were carried out with an interval between them of 2-3 min. With the help of biomechanical analysis, a series of nodal kinematic and dynamic parameters were established in key working positions. Subject of the research is time, linear, angular and speed characteristics, trajectory of Gravity center, pressure force, etc. Through the method of expert evaluation, based on qualitative criteria, all the repeated subjects of the research are grouped into three categories: positive, negative, and intermediate quality (borderline). The dynamics of positive and negative repetitions, as well as those defined as borderline, have been established. Additionally, the best and worst repeats from all 25 repetitions were determined.

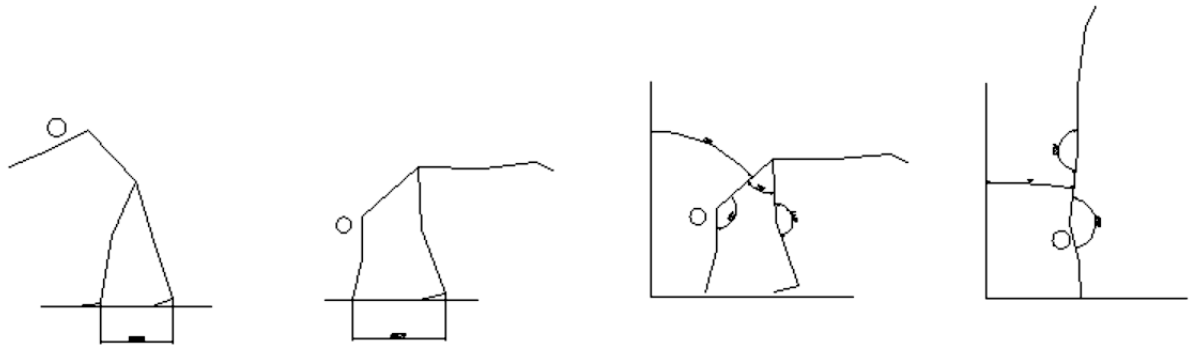

Figure 1. *Parameters subject of the research: linear characteristics, joint and segment angles in key positions*

The studied time characteristics are related to determining the duration of each of the phases (sec), into which the studied exercise is conditionally divided.

From the linear characteristics, the length of the step after stepping forward at the start of the exercise and the distance between the front foot and the line of the arms at the moment of contact with the support were recorded (Figure 1).

The established angular characteristics are joint and segmental angles. Joint angles at the shoulders, hips, and knees at the time of initial contact with the support and shoulder and hip angles during staying in handstand were measured. In the same key positions, a segmental angle between the vertical and the torso was found (Figure 1).

From the velocity characteristics, the initial velocity of the forward ankle when pushing off from the support and the average linear velocity of the rear

ankle during its upward swing movement to handstand were recorded.

The specialized platform allowed the dynamics and direction of the Center of pressure (CP) to be recorded: Center of pressure - x, y, z (mm). The established dynamic characteristic is the pressure force on the platform: Force plate Fx, Fy, Fz (N).

RESULTS

The collected data were systematized in tables and statistically processed by Frequency analysis, Descriptive Statistics, and Paired-Sampled T-Test. The study of the ratio between the determined three groups repeats shows that 14 performances are positive, 8 negative and 3 are defined as borderline. In percentage, this ratio is 56:32:12 (Figure 2). The chronological distribution of the three quality levels during the training session was determined. A long series of 6 consecutive positive repetitions was established in the second half of the experiment – from the 15th to the 20th trial.

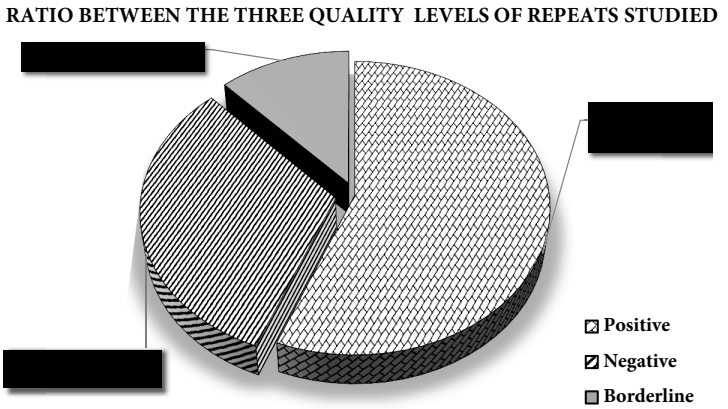

Figure 2. *Results of the frequency analysis of the studied repetitions according to the defined quality levels*

A comparative biomechanical analysis of the repeats performed in one training session was performed. In this regard, the phase structure of the studied exercise was determined. The comparison of the established parameters was made on the basis of key moments in each phase of the studied exercise.

Figure 3 shows the established time characteristics for each of the phases in the three types of repetitions. The phase of the closing actions associated with holding a handstand is logically the longest in the positive repetitions and the shortest in the negative trials. Preparatory actions, which by default should be of optimal duration, are longest in negative and shortest in boundary repetitions.

The average duration of the preparatory actions in the positive performances was 0.48 s. The duration of the main actions in the positive and negative trials was almost identical (0.70 and 0.71 s), while in border trials it is shorter (0.63 s).

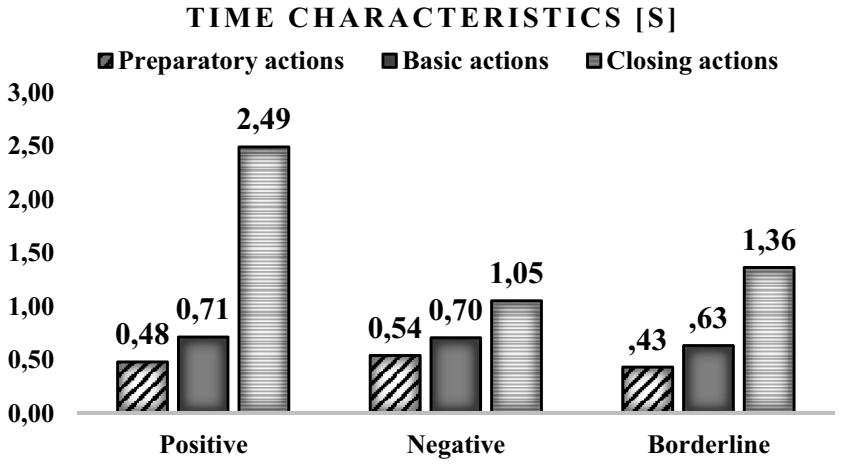

Figure 3. *Duration of handstand phases in the three repetition groups studied*

Tablel 1. *Results of the movements studied – kinematic and dynamic parameters*

	Positive Trials				Negative Trials				Borderline Trials			
	N	Mean	SD	p	N	Mean	SD	p	N	Mean	SD	p
Distance first step [m]	14	0.74	.04	<.05	8	0.75	0.04	<.05	3	.74	0.04	<.05
Distance from leg to arms [m]	14	0.74	.03	<.05	8	0.73	.04	<.05	3	.74	0.04	<.05
Angle Shoulder [deg]	14	142.71	3.79	<.05	8	143.25	2.66	<.05	3	143.33	2.66	<.05
Angle Hip [deg]	14	62.86	4.44	<.05	8	62.63	4.07	<.05	3	66.67	4.07	<.05
Angle Knee [deg]	14	171	4.17	<.05	8	172.88	4.61	<.05	3	172.67	4.61	<.05
Angle Trunk to Vertical [deg]	14	44.36	3.71	<.05	8	42.13	2.36	<.05	3	43.67	2.36	<.05
Angle Shoulder 2 [deg]	14	161.29	5.55	<.05	8	162.50	2.39	<.05	3	163.00	2.39	<.05
Angle Hip 2 [deg]	14	175.07	4.12	<.05	8	174.25	4.33	<.05	3	176.67	4.33	<.05
Angle Trunk to Vertical 2 [deg]	14	11.93	1.73	<.05	8	12.88	1.81	<.05	3	12.33	1.81	<.05
Velocity Average swing leg [m/s]	14	3.52	.32	<.05	8	3.58	0.32	<.05	3	3.40	0.32	<.05
Velocity stand leg V0 [m/s]	14	3.71	.40	<.05	8	4.12	0.57	<.05	3	4.02	0.57	<.05
Force at start [N]	14	641.36	62.67	<.05	8	648.88	54.24	<.05	3	696.67	54.24	<.05
Force at end [N]	14	682.93	45.87	<.05	8	671.63	31.04	<.05	3	668.33	31.04	<.05

Table 1 illustrates the data from the detected linear, angular, speed, and force characteristics of the movements.

It is evident that the difference in stride length during the preparatory actions in the three types of repetitions is insignificant. The situation is similar for the length between the arms and the supporting leg during the basic actions. Regularity has been established, regarding these two linear characteristics, which we consider interesting. The values of the positive trials are the same, i.e. symmetrical. In the other two types of repetitions, an asymmetry between these two parameters was found.

The registered joint angles in the shoulder, hip, and knee joints in the defined key working positions in the three types of repetitions have similar values. The established segment angles in the two investigated key positions also have similar values in the three types of trials.

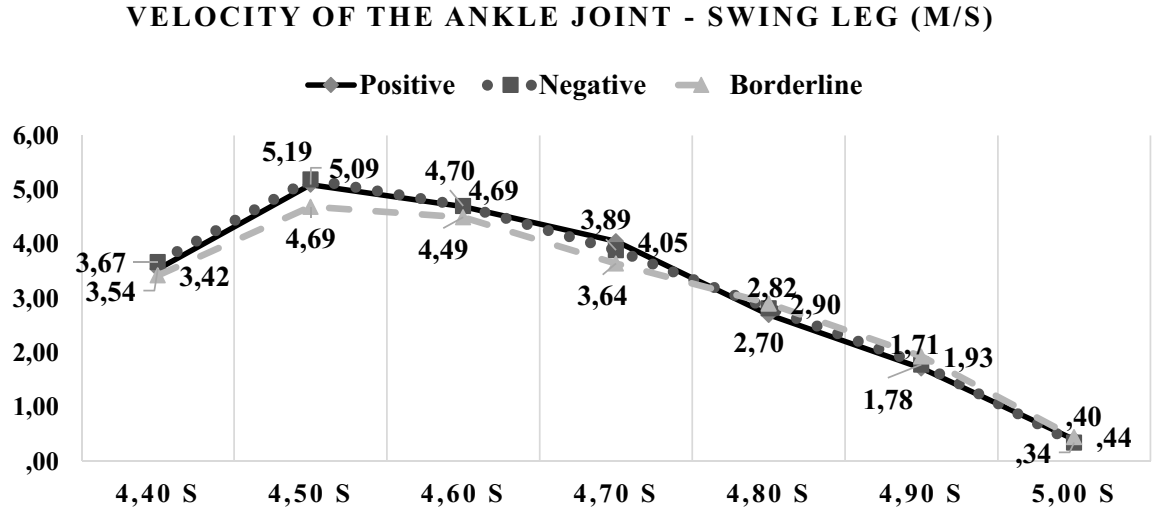

Figure 4. *Average linear velocity of the ankle joint of the swing leg during the main movements*

In Figure 4 graph of the average linear velocity of the ankle joint of the swing leg in the three types of trials is shown. It can be seen that the values of this parameter for the three categories of repetitions are extremely close. A similar situation is observed in the comparison of the initial velocity (V0) of the ankle joint of the pushing leg (Table 1).

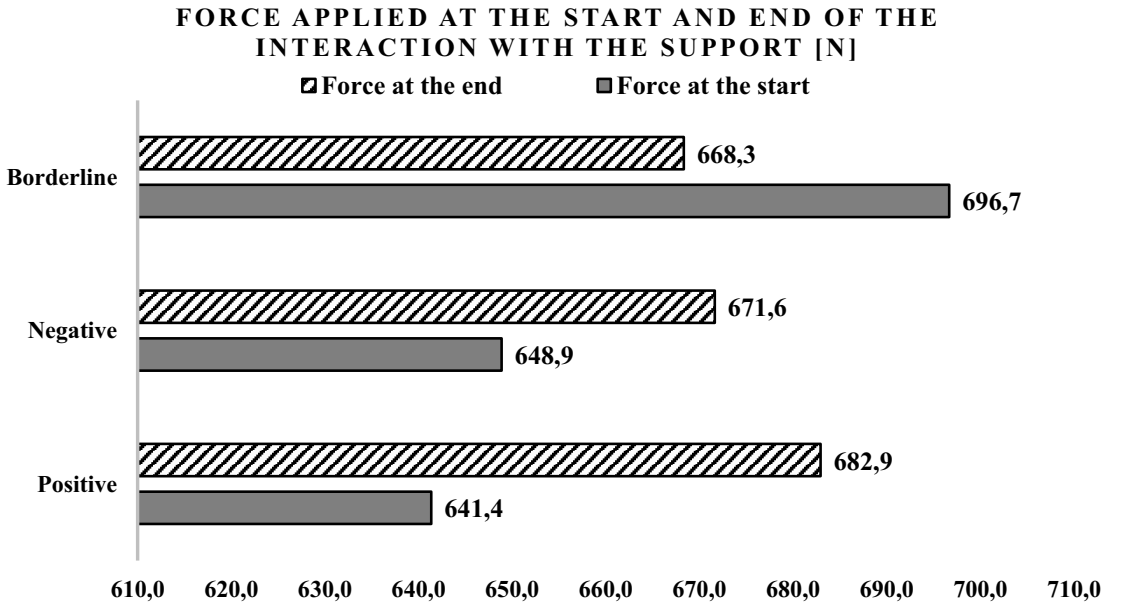

Figure 5. *Magnitude of the effort at the beginning and final of the interaction with the support*

Figure 5 shows the collected data on the magnitude of the effort at the beginning and final of the interaction with the support. The lower average value of the starting effort in the positive trials is striking, which can be explained as a consequence of better coordination associated with more economical actions.

Table 2. *Data from specialized platform "Bertec Force Plates" – dynamics of Center of pressure (mm)*

Indicators	FPG-CP-x (mm)			FPG-CP-y (mm)		
	Left (-), right (+)			Backward (+), forward (-)		
Phase / Quality	Mean	SD	p	Mean	SD	p
MA - Positive	6.13	23.69	<.05	-30.63	26.33	<.05
MA - Negative	13.90	17.93	<.05	-42.31	19.06	<.05
MA - Borderline	-5.17	21.82	<.05	-37.03	18.51	<.05
FA - Positive	-16.23	17.21	<.05	-46.92	36.78	<.05
FA - Negative	-15.30	20.12	<.05	-62.12	7.59	<.05
FA - Borderline	-11.58	14.53	<.05	-37.77	17.53	<.05

Note: MA – main actions, FA – final actions

Table 2 presents the data on the fluctuations of the Center of pressure during contact with the support for the three types of repetitions. The established values of this parameter in the positive trials are logically and naturally lower.

Table 3. *Data from the specialized platform "Bertec Force Plates"*

Indicators	Force plate Fx (N)			Force plate Fy (N)			Force plate Fz (N)		
	Backward (+), forward (-)			Left (+), right (-)			Down (-), up (+)		
Phase / Quality	Mean	SD	p	Mean	SD	p	Mean	SD	p
MA - Positive	86.05	14.81	<.05	6.91	4.88	<.05	570.12	9.36	<.05
MA - Negative	94.62	11.88	<.05	11.05	2.21	<.05	559.73	24.35	<.05
MA - Borderline	84.55	14.09	<.05	4.61	5.26	<.05	566.12	20.73	<.05
FA - Positive	21.94	8.51	<.05	-1.50	5.15	<.05	679.24	4.61	<.05
FA - Negative	15.35	3.77	<.05	-.34	.80	<.05	680.96	.89	<.05
FA - Borderline	8.37	6.20	<.05	.85	1.91	<.05	632.50	182.05	<.05

Note: MA – main actions, FA – final actions

Table 3 shows the collected data for the applied platform pressures (Fx, Fy, Fz) during the main and final actions. In positive trials, higher values on the X-axis stand out when maintaining balance during final actions.

DISCUSSION

The comparative biomechanical analysis was carried out based on the following phase structure:

- Preparatory actions - include i.p. standing, raising outstretched hands to the top, stepping forward, and pointing the arms forward and down to the support;
- Main actions - include the interaction of the arms with the support, in which three actions are realized simultaneously: pushing with the hands down-forward, pushing off from the supporting leg, and swinging with the swing leg back and up;
- Final actions - include bringing both legs together in a vertical position and keeping the body in a handstand position.

In Figure 6 the key working positions for each of the phases are shown.

The studied exercise is from a group of individual balance acrobatic exercises. It can be characterized as basic and of low difficulty. Proceeding from the established norms for the execution of a handstand via swing of the leg, several key moments can be indicated: optimal length of stepping and placing the hands forward during the preparatory actions, combining in one impulse the pressure (magnitude and direction) of the hands in the support, the pushing-up from the support leg and the swing with the swing leg during the main actions and the placement of the CG on the support area during the final actions.

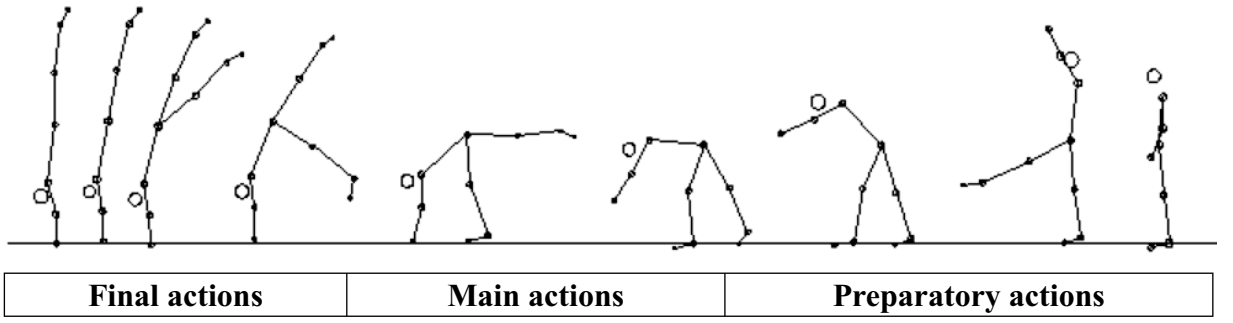

Figure 6. *Phase structure and key positions*

The conducted research is aimed at creating a quantitative assessment of the performances of the studied exercise. According to Filev (1976), assessing reliability in biological systems is significantly more difficult than in technical ones. Filev offers various formulas for quantitative assessment. One of them aims to establish the probability of error-free execution: P = n-k/n, where n – is the number of repetitions, k – is the number of errors, and P – the probability of error-free execution. Substituting data from the present study into this formula yields P=0.56, i.e. 56%.

In this study, we reached the same result in determining performance stability by defining the percentage ratio of the results obtained from the frequency analysis of the three trial categories (positive, negative, and borderline).

It is interesting to note that regarding the biomechanical study, pre-expectations were associated with data collection that much more clearly distinguished positive from negative performances. The obtained mean values of the parameters, subject to this study, did not differ significantly according to the performance category – positive, negative or borderline trial. The explanation for these results is related to the small coordination of the studied exercise, the high qualification of the performer and the small difference in the quality of the performed three types of repetitions.

Nevertheless, the detailed analysis of the data from the specialized platform shows differences in the dynamics of the studied indicators in the three types of trials. Differences and similarities were found both between positive, negative, and borderline repeats and within each of these groups. It was found that the majority of positive trials had similar values of the studied parameters. In the remaining two categories, the registered values have greater differences in each of the groups - negative and borderline performances.

In future similar studies, it is planned to expand the range of subjects and include exercises with increased coordination levels.

CONCLUSION

The biomechanical study carried out using a specialized platform found the following main differences between the positive and the other two categories of repetitions (negative and borderline): significantly longer final actions (2.49 sec); the same values of the length of the step during the preparatory actions and the distance between the hands and the supporting leg during the main actions (0.74 m); less effort at the beginning of the interaction with the support (641 N).

Based on the data collected in this research, it can be concluded that the athlete, subject of the study, realize peak reliability and stability when performing an individual balance exercise with small difficulty in the second half of the training session by executing a series of 6 consecutive positive repetitions. Performance stability is rated at 56%. This finding can be considered when preparing the athlete for participation in a competition through adjustments in the special warm-up.

REFERENCES

Angelov, V. (2010). Izsledvane na sigurnostta i stabilnostta pri izpalnenie na sastezatelnite serii na akrobatichna pateka", *Nauchni trudove RU, t*om 49, seriya 8.2, str. 83-88.

Bernshteyn., N. A. (1966). Ocherki po fiziologii dvizheniy i fiziologii aktivnosti. Moskva: Med.

Gambaryan, A., Yu. Gasparyan (1967). Nadezhdnost' i tekhnicheskiy progres. *Nauka i zhizn',* № 8.

Donskoy, D. D. (1969). Puti napravlenogo razvitiya sistemy dvizheniy. *TPFK. № 6.*

D'achkov, V. M. (1967). Ob"yektivnyye kriterii otsenki vysshego masterstva v sporte. *TPFK, № 4.*

Filev, F. (1976). Sigurnost pri izpalnenieto v sportnata gimnastika. Sofiya: MiF.

Korenberg, V. B. (1970). Nadezhnost' ispolneniya v gimnastike. Moskva: FiS.

Sorin, Ya. M. (1969). Fizicheskaya sushchnost' nadezhnosti. Moskva: Standartov.

Ukran, M. L. (1971). Metodika trenirovki gimnastov. Moskva: FiS.

Chorafas, D. N. (1963). *Procesy statistjczna i niezawodonose urradzen* Warzawa.

Luebbert, G. (1956). Literature Guide on Failure Control and Reliabilty. Stanford: Electronic Laboratories.

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THE CHANGES IN THE COD OF POINTS – MEN`S ARTISTICS GYMNASTICS (2021 - 2024)

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ABSTRACT
The main task of the cod of points in artistic gymnastics - men is to provide objective means for evaluating men's gymnastics exercises at all levels - at regional, national and international competitions, to ensure the identification of the best gymnasts in each competition, to guide coaches and gymnasts in creating their competitive exercises.
The aim of this study is to analyze the changes in the cod of points in artistic gymnastics - men / 2020 - 2024 /, and to establish their influence on the composition of the competitive exercise of the floor exercise.
Exercises were chosen at random performed randomly by elite gymnasts who participated in international championships in 2021 and 2022, on which diagrams have been prepared in order to establish the difference in the start value of their exercises in the respective competitions.
In the research, we used the following methods: video analysis, expert evaluation, and pedagogical observation.
Every four years, cod of points in artistic gymnastics – men undergo changes aimed at reducing the subjectivity of the judges in the evaluation of competitors, more correct and accurate recording of the exercises.
We believe that the obtained results will help the specialists dealing with artistic gymnastics in compiling the competitive combinations of floor exercises.

Keywords: *artistic gymnastics, cod of points, changes.*

INTRODUCTION

The system of sports improvement contains many components, and the indicator of the effectiveness of the preparation is the sports result. It is known that a high level of technical preparation is one of the decisive factors for reaching high sports achievements.
Increasing technical mastery is a major task of the daily training process. Technical training is considered one of the most essential sections of sports preparation (Hadjiev, 1978).

The complication of the competition program and the improvement of executive mastery is the main feature of the sport for high achievements in artistic gymnastics. Reaching new technically complex and risky exercises becomes the main professional function of a coach and gymnast.
The end of the 1980s and the beginning of the 1990s marked a new era in the development of gymnastics, with new complex technical and coordination exercises being included in the routines. The next most significant change is the introduction of the new evaluation system and fundamentally new code of points, based on open evaluation and limitation of performed exercises.

The main task of the Code of points for artistic gymnastics - men is to provide an objective means of evaluating men's gymnastics routines at all levels – at regional, national and international competitions, to ensure the identification of the best gymnasts in each competition, to guide the coaches and gymnasts in the creation of their competition routines. The collective of authors creating the rules gives instructions for the technical execution of the exercises and determines their complexity, and the tendency is for the difficulty of performing the exercises to increase more and more.
On the one side, the Code of points set the direction for the development and improvement of modern gymnastics and on the other side, it serves as a means of evaluating the skills and sportsmanship of the competitors (Kurtev, 2013).
According to Petrova (2017), the changes in the CoP direct the attention of specialists to the attractiveness of gymnastic routines.

It is interesting to note that as the main actors in the evaluation of athletes, judges are also the subject of research. Bard et col. (1980) conducted an experiment with seven judges, four of whom were experienced and three of whom had little experience. The results obtained from the study show that the expert judges fixate to a greater extent on the upper body of the gymnasts, while the novice judges concentrate their attention on the legs. As expected, more experienced judges detect more errors in performances.
The **aim** of this study is to analyze the changes in Code of points for artistic gymnastics - men (2021-

2024) and to determine their impact on the composition of floor exercise competition routines.
In this regard, we set ourselves the following ***tasks***:
1. To analyze routines of floor exercise.
2. To establish the difference in the start value of the combinations evaluated according to the rules for 2017-2021 and the current rules – for 2021-2024.

METHODS

The object of the research is the combinations of floor exercises. The subject of research is the changes in the start value (for difficulty) of the competitors.

Research methods

In order to fulfill the set aim and tasks of the research, we used the following methods: pedagogical observation, video analysis, and expert evaluation.

Procedure

We conducted the study in June 2022. We examined the floor exercise routines performed by the eight finalists at OG Tokyo 2020. Using expert evaluation, we analyzed the competitors' routines and randomly selected two routines that we evaluated under the 2021-2024 rules.

RESULTS

The international Code of points undergoes changes every four years, aimed at reducing subjectivity on the part of the judges in evaluating the competitors, more correct and accurate marking of the exercises, and more and more perfect in terms of technical execution and difficulty.
Following the changes made to the Code of points for the new Olympic cycle (2021–2024), the start value remains open (i.e., there is no difficulty score limit). These changes purpose to balance the start value and performance, as well as strict differentiation between individual gymnasts. Most of the changes are aimed at preserving health and reducing injuries among gymnasts, namely allowing the use of a soft (10 cm) mat on the rings apparatus, as well as increasing the height of the apparatus by 10 cm. The ban on the performance of some complex exercises by young gymnasts (up to 17 years old) on the apparatus of rings, parallel bars, and floor exercise remains.

According to the Code of points for artistic gymnastics - men, each exercise performed by the competitors receives a corresponding value: A= 0.1, B=0.2, C=0.3, D=0.4, E=0.5, F=0.6, G=0.7, H=0.8, I=0.9.
In floor exercises, the main change is the increase in the duration of gymnasts' routines from 70 to 75 seconds. The main goal is to perform more choreographed movements between series of acrobatic exercises.

The next change is the unification of some of the exercises with different value under one number with the same value, which makes it impossible for gymnasts to perform more than one of these exercises.
The elimination of the number of "connections" between acrobatic elements on the floor exercises is the other change in the rules of this apparatus.
Figure 1 shows the start values of R. Z. – ESP, a participant in the Tokyo 2020 Olympic Games. His start value at the Olympic festival was worth 6.60 points, but judged under the new rules his score is 5.60 points. One of the reasons for this difference is the removal of direct "connections" between saltos forward with a turn around the longitudinal axis (twists)

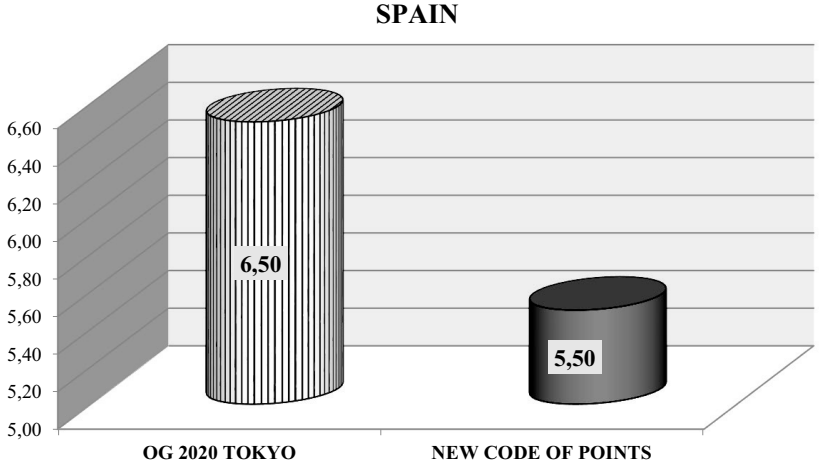

Figure 1. *Start values on the floor exercise of R. Z. – ESP*

An example of this difference is illustrated in Figure 2. According to the rules of COP 2017-2021, the "connection" between saltos with longitudinal axis turn exists. For the performance of an acrobatic series of salto backward with a 900° turn + a saltos forward with a 360° turn, the competitor receives a 0.1 bonus, while according to the new CoP 2021-2024, this "connection" is dropped. This is one of the reasons for the decrease in its starting value.

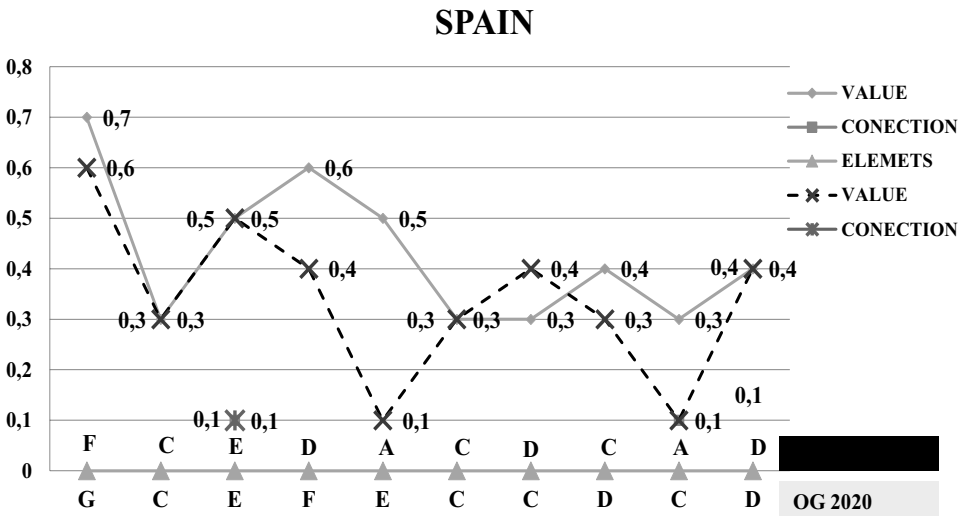

Figure 2. *Difficulty of floor exercises of R. Z. – ESP*

Another significant reason for the differences in the start values of the competitors is the combining of exercises with different or same value (according to the old CoP 2017-2021). As a result, the competitor is not allowed to perform both exercises in one combination, which leads to the lowering of his start value. An example of this is a double salto forward piked and a double salto forward piked with a 180° turn. According to the old CoP, these are two separate exercises with value E and F, but according to the new one - they are consolidated as exercises under the same number and with the same E value, which, when performing both exercises in the combination, leads to the disregard of one of them (Figure 2).

The start value of A. D. - ISR of the Olympic tournament is 6.60 points, respectively, but judged by the New CoP 2021-2024, its start value is lower by 0.50 points, respectively 6.10 points (Figure 3).

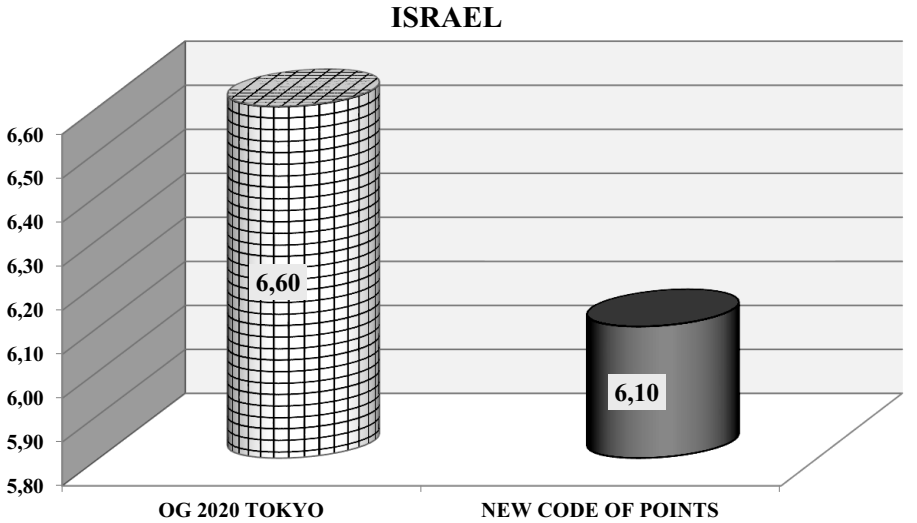

Figure 3. *Start values on the floor exercise of A. D. – ISR*

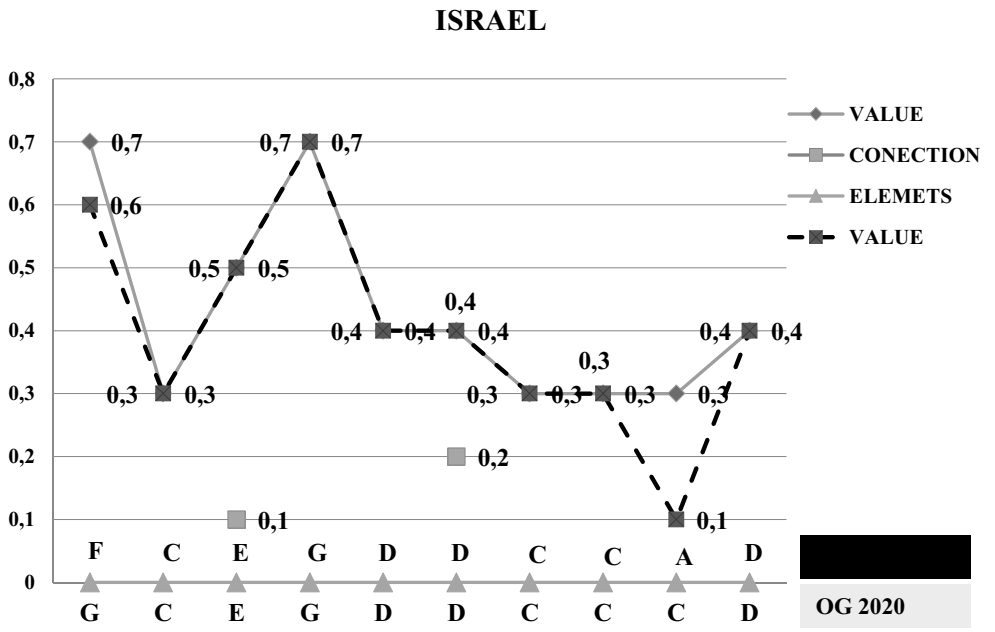

Figure 4. *Difficulty of floor exercises of A.D. - ISR*

The lower value of the start value of A. D. - ISR (Figure 4) is due to the reasons listed above, namely the loss of the "connection" between the acrobatic exercises salto forward with a 360° turn + salto forward with a 900° turn = 0.10 points, as well as salto backward with a 900° turn + salto forward with a 720° turn = 0.20 points, thus he loses 0.30 points from his start value. Also performs in its combination a salto forward 360° turn of C value and a salto forward 540° turn of the same value. These two acrobatic exercises are entered in the CoP under the same number, which leads to the judges disregard the second exercise, which is the reason for reducing his start value.

The next reason for the drop in starting scores of our selected Spanish and Israel competitors in Figures 1 and 3 respectively is that quite a few of the exercises in the NEW CoP 2021-2014 are of modified value – respectively lower or higher. An example of this is the first acrobatic series performed by the two competitors, namely a double salto forward tucked with a 540° turn, this acrobatic exercise receives a value of G= 0.70 points, according to the old rules, while according to the new rules it receives F= 0.60 points.

DISCUSSION

The changes to the CoP 2021-2024 of floor exercises are significant in terms of the safety of competitors in this rather traumatic sport. Increasing the duration of floor exercises competition routines will result in more choreographed elements being performed while also giving competitors more time to "rest" before performing complex acrobatic series. The changes related to the removal of "connection" between saltos with a longitudinal axis turn, the consolidation of exercises under the same number in the CoP, as well as changing the value of some of them, affects the compositional structure of the combinations. The connection between two or more saltos with longitudinal axis turn are replaced by others, between saltos with turn + double saltos or between saltos with longitudinal axis turn + saltos. A tendency towards the performance of over-complicated acrobatic series is noticed, an example of this is a triple salto backward piked which has a value of I = 0.90 points.

Restricting competitors from using the same diagonal of the square more than three times in a row led to the use of exercises such as the carthwheel and dive roll, which varied the gymnasts' routines.

In conclusion, we can summarize that some of the above-mentioned changes in the new CoP lead to a lowering of the initial rating of the competitors. This, in turn, will lead to a greater variety of acrobatic exercises used in gymnasts' routines.

REFERENCES

Bard, C., Fleury, M., Carrière, L., Hallé, M. (1980). Analysis of gymnastics judges' visual search. *Research Quarterly for Exercise and Sport*, 51(2), 267-273

Kurtev, Zdr. (2013). Promenite v sadiyskia pravilnik po sportna gimnastika – mazhe (2013 – 2016 g.) i vliyanieto im varhu nachalnite otsenki na sastezatelnite kombinatsii. *Sport i nauka*, izv. br., No 2, 93 – 98

Hadzhiev, N. (1978). Struktura na tehnikata na gimnasticheskite uprazhnenia. *Vaprosi na fizicheskata kultura*, No 3

Federation Internationale de Gymnastique (2017). *Code of Points – Men's Artistic Gymnastics*, 2017-2021, Lausanne, Switzerland

Federation Internationale de Gymnastique (2021). *Code of Points – Men's Artistic Gymnastics*, 2021-2024, Lausanne, Switzerland

Petrova, M. (2017). Expert analysis of the floor exercise training system. *Proceeding book. International Scientific Congress „Applied Sports Sciences"*, NSA Press, pp. 66-69

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LONGITUDINAL STUDY OF THE SPECIFIC INDICATORS DETERMINING THE OLYMPIC SWIMMING FINALISTS

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ABSTRACT
Introduction: Systematic analysis of statistics from the Olympic Games and World Championships is the most accurate guide to defining the dynamics of performances. The analysis of biographies of finalist swimmers in the highest sports forums proves that age indicator is a reliable parameter for personalized sports realization. Different age indicators in the structure of the long-term training of elite swimmers are decisive, but age is a fundamental category for achieving maximum sports results.
Methodology: Information on the age indicators of 72 participants was collected. They took part in the final swims of the Olympic Games in 9 disciplines in a 24-year period (1992-2016). The data was systematized and analyzed, and the analysis is structured around the age of women finalists from the studied Olympic Games. Results: The comparison of the indicator of the average age of the participants in the final swims in 1992 and the participants in the final swims in the last studied Olympics (2016) shows that the difference between the two groups is significant. The critical value at df = 144 and α = .05 is equal to 1.98, which makes the difference statistically significant.
Discussion: The analysis of the average age of the Olympic finalists in the period 1992-2016 provides an excellent opportunity to identify trends in the dynamics of this important parameter. For the whole set of finals, summarizing all styles and distances, an increase in the age of women by 1.4-4 years was registered.
Conclusion: The average age of women finalists from the studied Olympic Games in 1992 (72 final results) is 20.0 years, and in 2016 it increased to 23.2 years (+ 3.2 years), and in the distance swimmers - from 20.4 years to 23.3 years. (+2.9 years).

Keywords: *swimming, relative age, elite swimmers, peak performance age*

INTRODUCTION

The study of the "age-achievement" relationship has immediate practical significance for predicting the sports performance in adulthood and justifying the selection of boys and girls in representative national teams. Based on a sufficiently large number of cases, the correlation dependence between the sports result in children and adolescents, and the optimal age for achieving maximum results was deduced (Platonov, 2012).

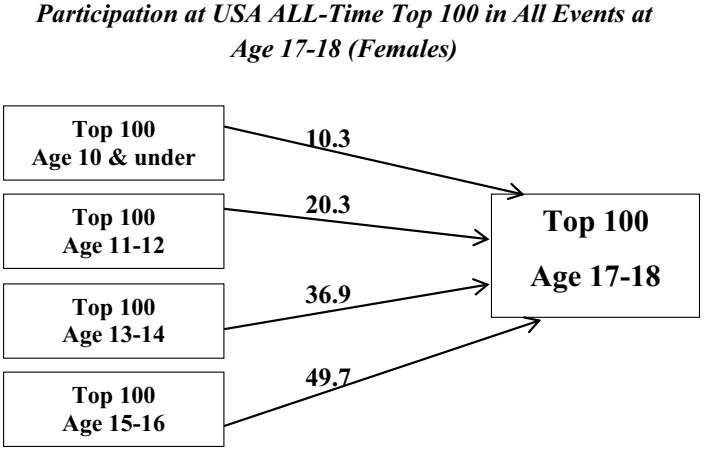


Figure 1. *Participants (in percentage) in the Top 100 (17-18 y.o. age group) from lower age groups*

About half of the elite swimmers in the Top 100 aged 17-18 are newcomers who have never been ranked in the Top 100 in any lower age group shown in Figure 1. Most of the future elite swimmers are slower than age group champions, especially up to 15-16 years of age. Many of the participants ranked in the Top 100 in the various age groups are not present in the Top 100 in the 17-18 age group (Sokolovas, 2006).

Age differences, as well as physical indicators (Kachaunov & Petrov, 2020) and growth rates of achievement between the two sexes, have been studied in freestyle swimmers in the disciplines from 50 m to 1500 m (Schulz & Curnow, 1988; Fairbrother, 2007; Tanaka & Seals, 1997; Angelov, 2021; Buhl et al., 2013). For swimmers, the age-related performance decline in freestyle swimming showed differences regarding the distance and the sex, with a greater decline in long-distance performances such as 1500 m freestyle and for women compared to men (Born et al., 2022). Schulz and Curnow find that women generally achieve peak swimming performance at a younger age compared to men. For freestyle swimmers, the age of peak swimming performance was described at ~21 years. Fairbrother reported that male freestyle swimmers achieved the age of peak performance for 50 m in their late 20s and early 30s. For 1500m freestyle, the age of peak swimming performance was achieved at ~18 years, in contrast to the 50 m distance, where the age of peak swimming speed was documented at ~23 years. Schulz and Curnow described a different development with a decline in the age of peak swimming performance with increasing race distance (Kollarz et al., 2013). The age of peak performance in a particular swimming style helps swimmers and coaches to predict declines in performance in that particular swimming style. With this knowledge, swimmers and their coaches are able to focus on the most appropriate swimming style in the particular age group (Vaso et al., 2013; Wolfrum et al., 2013; Allen et al., 2014; Zingg et al., 2014).

Analyzing the state of the age indicator in men, Angelov (2021) found constantly increasing age values. For this reason, the present study aims to establish the trends in the age index in the female sex.

METHODS

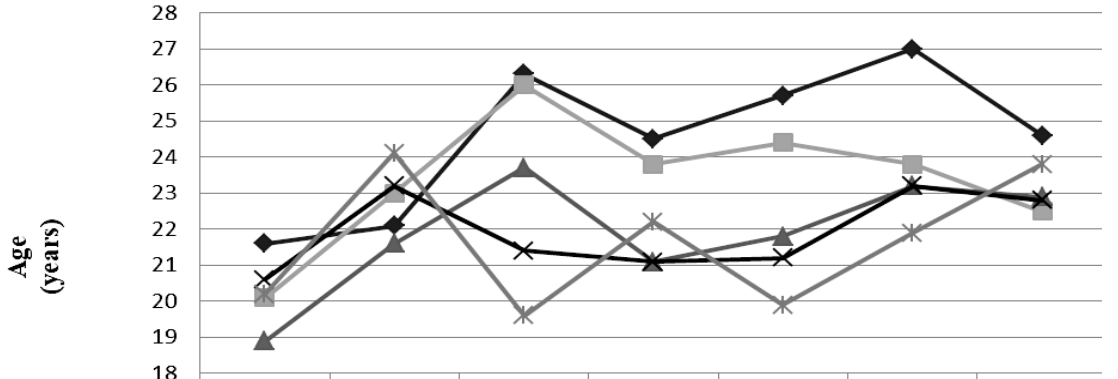
Information on the age indicators of all participants in the final swims was collected. They took part in the final swims of the Olympic Games in 9 disciplines in a 24-year period (1992-2016). Available data from the official protocols of the seven Olympics held in the period 1992-2016 were studied. The data were taken from the official website of the World Swimming Federation (FINA). The biographical data of the participants in the final swims were taken from the free encyclopedia Wikipedia, as well as from the official websites of the individual Olympic Games. The calculations of the age of the finalists were made based on the year and month of birth and their age on the date of the respective Olympic Games with an accuracy of 0.1 years. The statistical analysis was performed by the SPSS.19 statistical package (IBM, USA). Student's T-test for independent samples was used to find if there were statistically significant differences in the mean values of the measured parameters.

RESULTS

The analysis of the average age of Olympic finalists in the period 1992-2016 provides an excellent opportunity to establish the trends in the dynamics of this essential parameter. For the entire set of finals, summing up all styles and distances, an increase in women's age by 1.4-4 years was registered. The specifics for each discipline can be summarized as follows:

The absolute value of the growth as of 2016 compared to 1992 is 2.4 years for 100 m freestyle (Figure 2) and 4.0 years for 200m of freestyle. It is necessary to emphasize that deviations from this age within the period are very sensitive. The 2000 Sydney Olympic 100 m final had an average age of 26.0, and the 2016 Rio de Janeiro final had the lowest average age (22.5) after the Barcelona 1992-20.1.

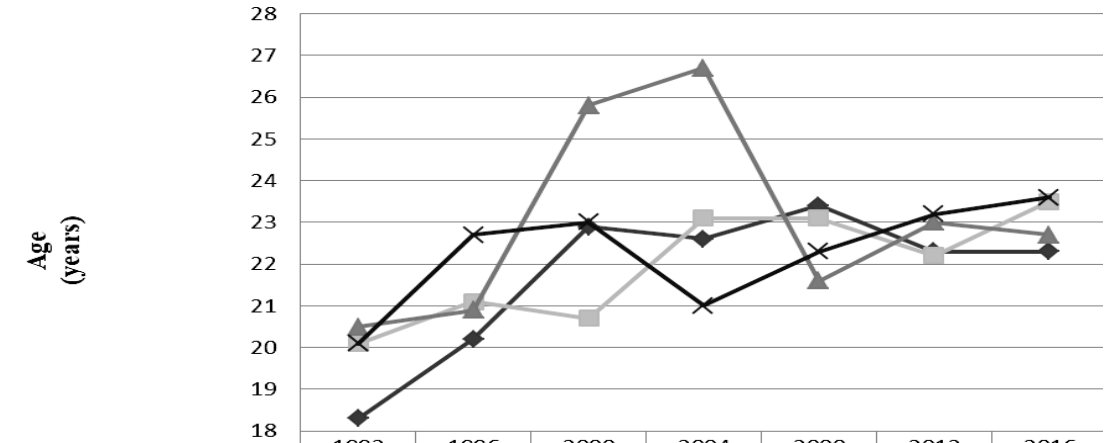
At 200 m freestyle, an average age of 21.9 years is established, with the highest growth (+4.0 years) of all women's finals. In addition, for only three Olympic cycles at the beginning of the studied period 1992-2000, one of the most violent jumps in age was registered (18.9-23.7 years).



	1992	1996	2000	2004	2008	2012	2016
50 freestyle	21.6	22.1	26.3	24.5	25.7	27	24.6
100 freestyle	20.1	23	26	23.8	24.4	23.8	22.5
200 freestyle	18.9	21.6	23.7	21.1	21.8	23.2	22.9
400 freestyle	20.6	23.2	21.4	21.1	21.2	23.2	22.8
800 freestyle	20.2	24.1	19.6	22.2	19.9	21.9	23.8
Average	20.3	22.8	23.4	22.5	22.6	23.8	23.3

Figure 2. *Average age of finalists in freestyle events between 1992 - 2016*

At 400 m freestyle, the increase is 2.2 years, and fluctuations are limited within the period. In the discipline 800 m freestyle, the absolute growth was 3.6 years, which was the third largest growth of all women's finals. The 100 m backstroke finalists (Figure 3) have the lowest starting average age (18.3 years), which forms the highest absolute growth (+4.0 years).



	1992	1996	2000	2004	2008	2012	2016
100 backstroke	18.3	20.2	22.9	22.6	23.4	22.3	22.3
100 breaststroke	20.1	21.1	20.7	23.1	23.1	22.2	23.5
100 butterfly	20.5	20.9	25.8	26.7	21.6	23	22.7
200 Individual medley	20.1	22.7	23	21	22.3	23.2	23.6
Average	19.8	21.2	23.1	23.4	22.6	22.7	23.0

Figure 3 *Average age of finalists in different strokes between 1992-2016*

The average age of all finalists in the 100 m breaststroke is 22.0 years, characterized by a smooth increase from 1992 (20.1 years) to 2016 (23.5 years). The 100 m butterfly finals had the highest internal dynamics and an atypical regressive trend (Figure 3) from the 2000 and 2004 Olympics until the end of the period in 2016. From the average age of these finals 25.8 and 26.7 years, respectively, the same sharply decreased 4 years later (21.6 years) and accelerated until the end at the level of 23 years.

In the individual medley, a stable dynamic was registered that marked positive total growth (+3.5 years) and an average total age of 22.3 years. Variance analysis of the female data shows a normal

distribution. This allows, by using Student's t-test for independent samples, to examine the differences in the mean age of the finalists (Table 1). The comparison of the average age of the female participants in the final swims in 1992 and the female participants in the final swims in the last studied Olympiad (2016) shows that the difference between the two groups is significant. The critical value at df=144, a=0.05 is equal to 1.98, which makes the difference statistically significant.

Table 1. *Comparison of the average values of the age index of the Olympic finalists since 1992 and 2016 – Women*

	1992			2016			Dif.	Sig.	
	n	$\overline{X}$	SD	n	$\overline{X}$	SD	d	temp	P(t)
Age	72	20.0	2.84	72	23.2	3.41	3.16	6.04	100

DISCUSSION

The research aimed to establish the trends in the age indicator of female participants in Olympic finals in the period 1992-2016. Understanding the optimal age is key to avoiding premature achievement of athletic performance (Rees et al., 2016; Brustio et al., 2021; Moesch et al., 2011). Summarizing the data shows that the average age of female finalists from the 9 studied disciplines in 1992 was 3.2 years lower than that of the finalists in the same disciplines in 2016. The low level of the indicator, to some extent, explains this difference at the beginning of the studied period (20.0 years), as well as the improvement of several factors determining the sports result. However, the final level of 23.2 years remains higher than the average level for the studied period (22.5 years). These results coincide with the results of other similar studies (Kollarz et al., 2013; Schulz & Curnow, 1988), which found an increase in the age index. Proof of the tendency to increase the age for achieving maximum results is also the fact that the mentioned studies are for previous periods, respectively 1896-1980 - Schulz and Curnow and 1994-2011 - Kollarz et al. The change in the average age of female finalists at the end of the 20th and the beginning of the 21st century is significant compared to the levels recorded in the last century. The average age in research from our period was 22.5 years, while in the period 1896-1980, it was at the level of 17 years. This difference of 5.5 years indicates the trend that this indicator follows not only in the last 24 years but also on a broader time span.

CONCLUSION

The optimal age for achieving maximum results is a key parameter that determines the structure of the long-term athlete development program. It is value depends on individual biological development, the swimmer's specialization in style and stroke, as well as on trends in the development of elite swimming.

The average age of the female finalists from the studied Olympic Games in 1992 (72 final results) was 20.0 years, and in 2016 it increased to 23.2 years (+3.2 years), and in the long-distance disciplines – from 20.4 years to 23.3 years (+ 2.9 years).

These values can serve as a guide for coaches and teams of swimmers as to the age at which they should seek peak performance from their athletes.

REFERENCES

Angelov, B. (2021). Vuzrastovi harakteristiki na finalistite v svobodnia stil ot olimpiiski igri v perioda 1990-2016 g. muje. *Godishnik na Nacionalnata sportna akademiq* "Vasil Levski" (Sofia). – NSA PRES, 2021

Born, D.P., Stäcker, I., Romann, M. (2022). Competition age: does it matter for swimmers?. *BMC Res Notes* 15, 82 (2022). https://doi.org/10.1186/s13104-022-05969-6

Brustio, P.R., Cardinale, M., Lupo, C., Varalda, M., De Pasquale, P., Boccia, G. (2021). Being a top swimmer during the early career is not a prerequisite for success: a study on sprinter strokes. *J Sci Med Sport*. 2021;24(12):1272–7

Buhl, C., Knechtle, B., Rüst, C.A., Rosemann, T., Lepers, R. (2013). A comparison of medley and freestyle performance for national and international swimmers between 1994 and 2011. *Open Access J Sports Med.* 2013 Mar 26;4:79-87. doi: 10.2147/OAJSM.S41171. PMID: 24379712; PMCID: PMC3871904.

Fairbrother, J.T. (2007). Age-related changes in top-ten men's U.S. Masters 50-m freestyle swim times as a function of finishing place. *Percept Mot Skills.* 2007 Dec;105(3Pt 2):1289–93

Kachaunov, M. & Petrov, L. (2020). Upper body anaero-

bic power and freestyle swimming performance. *Journal of Physical Education and Sport.* 20. 1957-1963. 10.7752/jpes.2020.04265.

Kollarz, C., Knechtle, B., Rüst, C.A., Rosemann, T., Lepers, R. (2013). Comparison of age of peak swimming speed in elite backstroke swimmers at national and international level. *OA Sports Medicine* 2013 Oct 01;1(2):19.

Moesch, K., Elbe, A.M., Hauge, M.L., Wikman, J.M. (2011). Late specialization: the key to success in centimeters, grams, or seconds (cgs) sports. *Scand J Med Sci Sports.* 2011;21:e282–290.

Platonov, V.N (2012). *Sportivnoe plavanie. Put k uspehu.* Kn. 2. Sovetskii sport, Moskva.

Rees, T., Hardy, L., Gullich, A., Abernethy, B., Cote, J., Woodman, T., Montgomery, H., Laing, S., Warr, C. (2016). The great British medalists project: a review of current knowledge on the development of the world's best sporting talent. *Sports Med.* 2016;46:1041–58.

Rüst, C.A., Knechtle, B., Rosemann, T. (2012). Women achieve peak freestyle swim speed at earlier ages than men. *Open Access J Sports Med.* 2012 Nov 12;3:189-99. doi: 10.2147/OAJSM.S38174. PMID: 24198602; PMCID: PMC3781914.

Schulz, R., Curnow, C. (1988). Peak performance and age among superathletes: track and field, swimming, baseball, tennis, and golf. *J Gerontol.* 1988 Sep;43(5):P113–20.

Allen, S. V., Vandenbogaerde, T. J., & Hopkins, W. G. (2014). Career performance trajectories of olympic swimmers: Benchmarks for talent development. *European Journal of Sport Science*, *14*(7), 643–651. https://doi.org/10.1080/17461391.2014.893020

Sokolovas, G. (2006). Analysis of USA swimming's all-time top 100 times. *In Proceedings of the Xth International Symposium on Biomechanics and Medicine in Swimming*; Vilas Boas, J.P., Alves, F., Marques, A., Eds.; University of Porto: Porto, Portugal, 2006; pp. 315–317.

Vaso, M., Knechtle, B., Rüst, C.A., Rosemann, T., Lepers, R. (2013). Age of peak swim speed and sex difference in performance in medley and freestyle swimming–A comparison between 200 m and 400 m in Swiss elite swimmers. *J Hum Sport Exerc.* 2013;8(4):954–65.

Wolfrum, M., Knechtle, B., Rüst, C.A. et al. (2013). Sex-related differences and age of peak performance in breaststroke versus freestyle swimming. *BMC Sports Sci Med Rehabil* 5, 29. https://doi.org/10.1186/2052-1847-5-29

Zingg, M.A., Rüst, C.A., Rosemann, T. (2014). Analysis of swimming performance in FINA World Cup long-distance open water races. *Extrem Physiol Med 3*, 2 https://doi.org/10.1186/2046-7648-3-2

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A STUDY COMPARISON FOR MOTOR ABILITIES FOR BOYS' BASKETBALL PLAYERS U14 & U16 IN TIRANA

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ABSTRACT
Basketball is a dynamic game, and as such, it requires that players must develop their motor abilities, especially at young ages, when the attention should be higher.
The aim of this study is to compare motor abilities performance in basketball at age groups U14 and U16.
To obtain the objectives of this study, field test measurements was performed on 110 boys' basketball players from 8 teams U14 & U16 randomly selected in Tirana city (Capital of Albania). In this study, 53 basketball players were in U14 age group, and 57 were in U16 age group. These measurements were done at respective motor abilities; anthropometric such as (body weight, height, and waist circumference), explosive power (long jump standing), flexibility (sit and reach test), speed (sprint 20m), agility (T-test & 10x5m), aerobic fitness (20m shuttle run test).
Comparing data analysis between group ages shows that all motor abilities performance in the U16 age group had higher results ($p < .05$) than U14, except flexibility, where no statistically significant difference was observed.
At this point, two questions are raised for further analysis by researchers: whether such a difference is because of the biological differentiations among the two age groups or that coaches of U16 focus more on motor abilities development during their practices rather than at U14.

Keywords: *basketball, agility, speed, power, youth*

INTRODUCTION

The coaches in youth basketball tend to practice more technical and tactical skills, neglecting the training of athletic motor skills. (Ceciliani, 2019; Ceciliani et al, 2005; D'Isanto, 2016; Valentini et al., 2018a and 2018b) The role of body movement is crucial in skill learning for physical activity. Muscular physical exercise can be combined with a technical or tactical annual training plan as an essential training element. The basketball game, as in several team games, has different positions during the game. Delextrat & Cohen (2009) studied the role of a team's work on strength, power, speed, and agility. They established those guards are better than centers at performing the Wingate Anaerobic test, suicide run test, agility T-test, and Single-leg jump. In addition, forwards are better than centers performing isokinetic testing of the knee extensors, and guards are better on suicide run tests than forwards.

Many articles were published (Erčulj et al., 2004; Zwierko & Lesiakowski, 2007; Abdelkrim et al., 2007) for the nature/type of movement that characterized basketball, such as sprint movement, quick change of direction or pace, vertical jump standing or on the move, as well as combined with dribbling, passing or shooting. These abilities are crucial for the future results of basketball players on the court. In contrast, in professional basketball, explosive power is the most significant characteristic of achieving good sports results (Aksovic et al., 2020). During a basketball game, there are different indicators, such as jumps which may vary from player to player, which shows us the importance of explosive power (Mclennes, Carlson, & McKenna, 1995). Passing and shooting, start acceleration, change of direction, and jumps are all explosive power manifested in the game of basketball. (Castagna et al., 2009; Casartelli et al., 2010; Battaglia et al., 2014).

For the success during the game, players must develop good physical fitness attributes (Castillo et al., 2021). To achieve higher performance in the training process, coaches must include physical fitness drills and detect players' deficits for appropriate training. In the ages of adolescence from 12-14 years which have significant body changes such as an increase in height or weight, physical fitness attributes are important (Faigenbaum et al., 2009). In Albania, a few study deal with motor abilities performance in youth basketball. The evaluation of the current state of physical fitness is the most reliable method to know if an athlete's performance is optimal in sports. This study compares motor abilities performance in basketball at age groups U14 and U16. We hypothesized that

the male U16 age group would possess better performance on motor abilities than the U14 age group.

METHODS

To resolve the study tasks, field test measurements were performed with 110 basketball players (boys) from 8 teams, U14 & U16, randomly selected in Tirana city (Capital of Albania). In this study, 53 basketball players were selected for the age group U14, and 57 players were selected for the U16 age group. These field test measurements were done to assess motor abilities; anthropometrics such as (body weight, height, and waist circumference); explosive power (long jump standing); flexibility (sit and reach test); speed (sprint 20m); agility (T-test & 10x5m**);** aerobic fitness (20m shuttle run test). Informed consent from parents was required for the children's participation in this study. Players were free to withdraw from all measurements at any time without explanation.

Measurement and testing protocols

Body height and body mass were measured using a Health O Meter 402 KL professional physician beam scale. Values were recorded to the nearest 0.1 cm and 100 g, respectively, while the tape was used to measure waist circumference. Standing long jump test (Eurofit, 1993) to measure the explosive power of the legs. The player stands behind a line marked on the ground with feet slightly apart. A two-foot take-off and landing are used, with the arms swinging and bending the knees to provide forward drive. The player attempts to jump as far as possible, landing on both feet without falling backward. Three attempts are allowed. The measurement is taken from the take-off line to the nearest point of contact on the landing (back of the heels). Record the longest distance jumped, the best of three attempts. For this test, equipment is required: a tape measure to measure the distance jumped, a non-slip floor for take-off, and a soft-landing area preferred.

Standing high jump tests were used to find the jumping performance.

Sit and reach test (Institute, 2007) to measure the flexibility of the lower back and hamstring muscles. This test involves sitting on the floor with legs stretched out straight ahead. Shoes should be removed. The soles of the feet are placed flat against the box. Both knees should be locked and pressed flat to the floor – the player may assist by holding them down. With the palms facing downwards, and the hands-on top of each other or side by side, the player reaches forward along the measuring line as far as possible. The coach has to ensure that the hands remain at the same level, not one reaching further forward than the other. After some practice, the player reaches out and holds that position for one to two seconds while the distance is recorded. The score is recorded to the nearest centimeter as the distance reached by the hand. For this test, Sit and Reach box is required.

Aerobic fitness (20m shuttle run test)

The player ran from one line to the other (20 m apart), where he/she had to touch the floor behind the line with one hand, turn around and run back with the signal of the beep test. This procedure will be followed till the player does not reach the other line with the stop signal from the beep test. Players have to run as fast as they can in order to cover the longest possible distance during the test run, and this distance will be the test's result. When athletes are unable to reach the finish line before they beep twice, the test ends.

Sprint test 20m

Players lined up at the start line, and they can perform when they are ready. The time starts when the player touches the beam of the first gate (bipi) and ends when the beam of the second gate (beep) is touched. The player has to use the maximum speed during the test.

T-test

Before the test player must perform an appropriate warm-up, the player starts this test with the feet shoulder-width apart, knees slightly bent, and one foot on the start/finish line. The player must perform the test by moving forwards, backward, and side to side (T -form). The player measures two attempts, and the best result is recorded.

Shuttle run 10 x 5 m test (Eurofit, 1993) to assess the speed and agility of the lower limbs. Marker cones and/or lines are placed five meters apart. The player starts with a foot at one marker. When instructed by the timer, the player runs to the opposite marker, turns, and returns to the starting line. This is repeated five times without stopping (covering 50 meters total). At each marker, both feet must fully cross the line. The time taken to complete 50

meters course is recorded. For this test, equipment is required: a stopwatch, measuring tape, marker cones, and a flat non-slip surface.

Statistical Analysis

A specific database was created in an excel file (pre and post-intervention test results) and then converted to an SPSS database. Descriptive statistics (mean and standard deviations) were calculated for the variables measured in this study. Differences by age category were calculated by the Independent Samples Test- Levene's Test for Equality of Variances. All variables measured in this study were tested for normality. A significant level of $p<0.05$ was accepted. All analysis was performed using the statistics software SPSS 20.0.

RESULTS

Data from table 1 show descriptive statistics (mean, SD, Std error mean) for body height, weight, BMI values, and waist circumference. The data are shown for each age category for the cadet (U14 yrs) and junior (U16 yrs) basketball group categories.

Table 1. *Descriptive statistics for anthropometric*

	Age Category	Mean	Std. Deviation	Std. Error Mean
Body Height cm	Cadet (U14 yrs)	173.4	9.8	1.0
	Junior (U16 yrs)	180.9	7.2	1.1
Body Weight	Cadet (U14 yrs)	66.8	12.8	1.3
	Junior (U16 yrs)	75.4	9.4	1.5
BMI	Cadet (U14 yrs)	22.1	3.1	0.3
	Junior (U16 yrs)	23.1	2.8	0.4
Waist Circumference	Cadet (U14 yrs)	80.3	9.5	0.9
	Junior (U16 yrs)	83.9	8.4	1.3

Data from table 2 shows descriptive statistics (mean, SD, Std error mean) for aerobic fitness (20m shuttle run test), a lower body explosive power (standing long jump test), flexibility (sit and reach test), speed (sprint 20m), agility using T-test and agility and also, jumping performance using standing high jump test. The data are shown for each age category as for cadet (U14 yrs) and junior (U16 yrs) basketball group categories.

Table 2. *Descriptive statistics for motor abilities performance*

	Age Category	Mean	Std. Deviation	Std. Error Mean
Aerobic Fitness 20m Shuttle Run- Total laps	Cadet (U14 yrs)	52.1	18.2	1.9
	Junior (U16 yrs)	63.6	17.5	3.1
Lower Body Standing Long Jump	Cadet (U14 yrs)	177.2	33.0	3.3
	Junior (U16 yrs)	207.4	29.8	4.7
Jump CMJ cm	Cadet (U14 yrs)	40.5	15.2	1.5
	Junior (U16 yrs)	50.6	8.4	1.4
Jump with steps cm	Cadet (U14 yrs)	46.6	16.7	1.6
	Junior (U16 yrs)	58.8	8.7	1.4
Flexibility Sit and Reach	Cadet (U14 yrs)	23.4	8.1	0.8
	Junior (U16 yrs)	23.9	8.4	1.3
Speed Sprint 20m	Cadet (U14 yrs)	3.5	0.3	0.0
	Junior (U16 yrs)	3.3	0.2	0.0
Agility 10x5m	Cadet (U14 yrs)	19.6	1.5	0.2
	Junior (U16 yrs)	18.2	1.3	0.2
T-test	Cadet (U14 yrs)	12.4	1.5	0.2
	Junior (U16 yrs)	11.4	1.0	0.2

Data results from table 3 show values for variables comparison by age category for body weight, height, BMI, and waist circumference. Data for all variables show a statistically significant difference in favor of the Junior age category except BMI values, where no significant statistical differences were found.

Table 3. *Independent Samples Test - Levene's Test for Equality of Variances*

	F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Body Height cm	3.42	.07	.00	-7.45	1.70
Body Weight	2.83	.10	.00	-8.63	2.23
BMI	1.51	.22	.08	-1.00	0.57
Waist Circumference	1.89	.17	.04	-3.59	1.72

Data results from table 4 show values for variables comparison by age category for aerobic fitness (20m shuttle run test), lower body explosive power (standing long jump test), flexibility (sit and reach test), speed (sprint 20m), agility using T-test and agility 10x5m and also, jumping performance using standing high jump test. Data for all variables show a statistically significant difference in favor of the Junior age category except flexibility (sit and reach test) values, where no statistically significant differences were found.

Table 4. *Independent Samples Test- Levene's Test for Equality of Variances*

	F	Sig.	Sig. (2-tailed)	Mean Difference
Aerobic Fitness 20m Shuttle Total laps	0.122	.73	**.00**	**-11.44**
Lower Body Standing Long Jump	0	.99	**.00**	**-30.21**
Jump CMJ cm	4.311	.04	**.00**	**-10.13**
Jump with steps cm	4.247	.04	**.00**	**-12.25**
Flexibility Sit and Reach	0.412	.52	.78	-0.42
Speed Sprint 20m	5.098	.03	**.00**	**0.22**
Agility 10x5m	1.561	.21	**.00**	**1.40**
T-test	3.133	.08	**.00**	**0.98**

DISCUSSION

Comparing data between group ages shows that all motor abilities performance for the U16 age group were higher ($p < .05$) than U14, except flexibility, where no statistically significant difference was observed.

Different studies show a substantial difference in jump

heights among basketball players during competitions (Hoare, 2000; Delextrat & Cohen, 2009). Furthermore, studies show that the best players tend to jump more. For example, if a player plays for 40 minutes during a basketball game, he may run 6km up to 7km, can make 40 different jumps, 120 ball catches, up to 280 change directions, and 80 ball passes. Therefore, Stojanović et al. (2012) emphasize that coaches must work on explosive power development for elite basketball players, as it significantly influences their performance. The same results were found in other studies.

The speed test (5 x 14m) has demonstrated that there are many differences based on age and sex. According to kinematic variables regarding the sprint time, it was noticed that it also differentiates based on age. Under-16 players sprinted faster than under-14 players as their intensity was bigger. The anaerobic capacity development is related to the growth of the players (Jakovljevic et al., 2012). The reason is the development of strength in a limited way due to its relationship with puberty and changes in size and cross-sectional area of the muscle, affecting muscle contraction and, therefore, the application of strength (Isler et al., 2008). From the above finding, we must consider having an age-related training process to confirm the physical and physiological differences.

All the variables related to accelerometry showed significant differences according to age. For example, older players have larger limbs, influencing the sprint result (Ramos et al., 2019). Furthermore, concerning the player's steps cycle, the differences between ages are directly connected to strength development (Castagna et al., 2008). Therefore, the fact strongly affects the result as the older players, in order to apply equal or greater strength, use less time and are more efficient in achieving a higher speed of movement.

Regarding lower body strength, results showed significant age-related differences. The Abalakov test shows differences depending on age in all variables analyzed. These results coincide with the result found in the literature, which affirms the importance of development in producing maximum strength (Rodrigues et al., 2017). As in the RSA test, concerning maximal strength value, the evolutional development and sex of the player are very important. (Laffaye et al., 2015). The difference between sexes is evident as the muscle's ability to contractile to generate maximum strength is higher than in a power exercise (Laffaye et al., 2014). Finally, Aerobic performance is crucial for athletes for the game's duration; it helps players recover faster and more efficiently from anaerobic situations (Castagna et al., 2010). The athlete's anaerobic performance is the most important descriptor (Ibanez et al., 2008). Anaerobic performance is classified into anaerobic capacity and power (Soslu et al., 2016).

At this point, there are two questions raised for further study analysis by researchers: this difference in motor abilities is because of the biological difference that occurs between two age groups, or is it that coaches at U16 focus more attention on motor abilities development during their practices rather than 14 years old.

REFERENCES

Ben Abdelkrim, N., El Fazaa, S., & El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British journal of sports medicine*, 41(2), 69–75. https://doi.org/10.1136/bjsm.2006.032318

Aksović, N., Kocić, M., Berić, D., Bubanj, S (2020). Explosive power in basketball players. *Physical Education and Sport*, 18 (1), 119 - 134 https://doi.org/10.22190/FUPES200119011A

Battaglia, G., Paoli, A., Bellafiore, M., Bianco, A., & Palma, A. (2014). Influence of a sport-specific training background on vertical jumping and throwing performance in young female basketball and volleyball players. *Journal Sports Medicine and Physical Fitness*, 54(5), 581-587.

Castillo, D., Raya-González, J., Scanlan, A. T., Sánchez-Díaz, S., Lozano, D., & Yanci, J. (2021). The influence of physical fitness attributes on external demands during simulated basketball matches in youth players according to age category. *Physiology & behavior*, *233*, 113354. https://doi.org/10.1016/j.physbeh.2021.113354

Casartelli, N., Müller, R., & Maffiuletti, N. A. (2010). Validity and reliability of the Myotest accelerometric system for the assessment of vertical jump height. Journal of strength and conditioning research, 24(11), 3186–3193. https://doi.org/10.1519/JSC.0b013e3181d8595c

Castagna, C., Manzi, V., D'Ottavio, S., Annino, G., Padua, E., & Bishop, D. (2007). Relation between maximal aerobic power and the ability to repeat sprints in young basketball players. *Journal of strength and conditioning research*, 21(4), 1172–1176. https://doi.org/10.1519/R-20376.1

Castagna, C., Chaouachi, A., Rampinini, E., Chamari, K., & Impellizzeri, F. (2009). Aerobic and explosive power performance of elite italian regional-level basketball players. *Journal of strength and conditioning research*, 23(7), 1982–1987. https://doi.org/10.1519/JSC.0b013e3181b7f941

Castagna, C., Abt, G., Manzi, V., Annino, G., Padua, E., & D'Ottavio, S. (2008). Effect of recovery mode on repeated sprint ability in young basketball players. *Journal of Strength and Conditioning Research*, *22*(3), 923-929.

Castagna, C., Manzi, V., Impellizzeri, F., Chaouachi, A., Ben Abdelkrim, N., & Ditroilo, M. (2010). Validity of an on-court lactate threshold test in young basketball players. *Journal of strength and conditioning research,* 24(9), 2434–2439. https://doi.org/10.1519/JSC.0b013e3181e2e1bf

Ceciliani, A. (2018). From the Embodied Cognition to the Embodied Education in the Physical and Sports Sciences. *Encyclopaideia,* 22(51), 11–24. https://doi.org/10.6092/issn.1825-8670/8424

D'Isanto, T. (2016). Pedagogical value of the body and physical activity in childhood, *Sport Science*, 9, 13-18

Di Tore, A.P., Raiola, G., D'Isanto, T. (2018). Situation awareness in sports science: Beyond the cognitive paradigm [Situacijska svijest u sportskoj nauci: Van kognitivne paradigme] *Sport Science*, 11 (1), 44-48.

Delextrat, A., & Cohen, D. (2009). Strength, power,

speed, and agility of women basketball players according to playing position. *Journal of strength and conditioning research,* 23(7), 1974–1981. https://doi.org/10.1519/JSC.0b013e3181b86a7e

Erčulj, F., Dežman, B., & Vučković, G. (2004). Differences between three basic types of young basketball players in terms of height and contact time in various jumps. *Kinesiologia Slovenica*, 10(1), 5-15.

Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the national strength and conditioning association. *Journal of strength and conditioning research*, 23(5 Suppl), S60–S79. https://doi.org/10.1519/JSC.0b013e31819df407

Laffaye, G., Choukou, M. A., Benguigui, N., & Padulo, J. (2016). Age- and gender-related development of stretch shortening cycle during a sub-maximal hopping task. *Biology of sport,* 33(1), 29–35. https://doi.org/10.5604/20831862.1180169

Laffaye, G., Wagner, P. P., & Tombleson, T. I. (2014). Countermovement jump height: gender and sport-specific differences in the force-time variables. *Journal of strength and conditioning research*, 28(4), 1096–1105. https://doi.org/10.1519/JSC.0b013e3182a1db03

Mancha-Triguero, D., García-Rubio, J., Calleja-González, J., & Ibáñez, S. J. (2019). Physical fitness in basketball players: a systematic review. *The Journal of sports medicine and physical fitness*, 59(9), 1513–1525. https://doi.org/10.23736/S0022-4707.19.09180-1

McInnes, S. E., Carlson, J. S., Jones, C. J., & McKenna, M. J. (1995). The physiological load imposed on basketball players during competition. *Journal of sports sciences*, 13(5), 387–397. https://doi.org/10.1080/02640419508732254

Hoare D. G. (2000). Predicting success in junior elite basketball players--the contribution of anthropometic and physiological attributes. Journal of science and medicine in sport, 3(4), 391–405. https://doi.org/10.1016/s1440-2440(00)80006-7

Isler, A.K.; Ariburun, B.; Ali, A.; Aytar, A.; Tandogan, R. (2008). The relationship between anaerobic performance, muscle strength and sprint ability in American football players. *Isokinet. Exerc. Sci,* 16, 87–92.

Ibáñez, S.J., Sampaio, J., Feu, S., Calvo, A.L., Gómez, M.A., Ortega, E. (2008). Basketball game-related statistics that discriminate between teams' season-long success. *Eur. J. Sports Sci,* 8, 369–372.

Jakovljevic, S. T., Karalejic, M. S., Pajic, Z. B., Macura, M. M., & Erculj, F. F. (2012). Speed and agility of 12- and 14-year-old elite male basketball players. *Journal of strength and conditioning research,* 26(9), 2453–2459. https://doi.org/10.1519/JSC.0b013e31823f2b22

Ramos, S., Volossovitch, A., Ferreira, A. P., Fragoso, I., & Massuça, L. (2019). Differences in maturity, morphological and physical attributes between players selected to the primary and secondary teams of a Portuguese Basketball elite academy. *Journal of sports sciences*, 37(15), 1681–1689. https://doi.org/10.1080/02640414.2019.1585410

Rodríguez-Rosell, D., Mora-Custodio, R., Franco-Márquez, F., Yáñez-García, J. M., & González-Badillo, J. J. (2017). Traditional vs. Sport-Specific Vertical Jump Tests: Reliability, Validity, and Relationship with the Legs Strength and Sprint Performance in Adult and Teen Soccer and Basketball Players. *Journal of strength and conditioning research*, 31(1), 196–206. https://doi.org/10.1519/JSC.0000000000001476

Soslu, R., Özkan, S.R., Göktepe, A.M. et al. (2016). The relationship between anaerobic performances, muscle strength, hamstring/quadriceps ratio, agility, sprint ability and vertical jump in professional basketball players. *J. Phys. Educ. Sport*, 10, 164–173.

Stojanovic, M. D., Ostojic, S. M., Calleja-González, J., Milosevic, Z., & Mikic, M. (2012). Correlation between explosive strength, aerobic power and repeated sprint ability in elite basketball players. *The Journal of sports medicine and physical fitness*, 52(4), 375–381.

Valentini, M., Bernardini, C., Beretta, A., & Raiola, G. (2018a). Movement and language development as an early childhood twin strategy: A systematic review. *Sport Mont*, 16(3), 107-112. https://doi.org/10.26773/smj.181019

Valentini, M., Riccardi, F., Raiola, G., Federici, A. (2018b). Educational research: Motor area and relational area during children's personality development, *Journal of Physical Education and Sport*, 18 (327), 2157-2174.

Zwierko, T., & Lesiakowski, P. (2007). Selected parameters of speed performance of basketball players with different sport experience levels. *Studies in Physical Culture and Tourism*, 14, 307-312.

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DIFFERENCES IN THE EXPLOSIVE POWER OF BASKETBALL PLAYERS OF DIFFERENT AGE

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ABSTRACT

Physical performance and fitness in basketball are mostly influenced by lower-limb explosive power. The aim of this study was to examine the differences in the explosive power of the lower extremities measured by countermovement jump (CMJ) in basketball players of the regional level of competition in relation to the age category. Forty-one male participants regional level were divided in three age categories U18 (N = 14; height: 1.85 ± 0.04 m; body mass: 80.18 ± 10.71 kg; age: 17.2 ± 0.6 years), U16 (N = 13; height: 1.79 ± 0.06 m; body mass: 67.8 ± 7.4 kg; age: 15.4 ± 0.6 years), U14 (N = 14; height: 1.72 ± 0.12 m; body mass: 56.35 ± 14.11 kg; age: 13.2 ± 0.5 years) and participated in cross-sectional study. Each subject performed three maximal CMJs on a Quattro Jump force platform to determine differences in vertical jump parameters between groups. The performances of jump height from flight time (JHFT), relative maximal force (RMF), relative maximal power (RMP), relative energy (RE), jump time (JT), countermovement time (CMT), push-off time (POT). ANOVA analysis showed statistically significant differences between groups in JHFT, RMF, and POT ($p < 0.05$). The post hoc test indicates that the youngest U14 age group was accountable for these differences. However, no significant differences were observed between tested age categories in RMP, JT, RE, and CMT. These results reveal differences in some of the force parameters, suggesting that these differences are attributed to the youngest group of basketball players.

Keywords: *team sport, force, jump height, lower extremities, youth*

INTRODUCTION

Basketball can be characterized as a game with a combination of short rests and short high-intensity activities (Calleja-González et al., 2016). These activities combine all motoric abilities such as speed, agility and explosive power. Male basketball players travel between 5-6 kilometers during a single game (Stojanović et al., 2018). The explosive power of lower limbs can be considered as a dominant ability in basketball. Considering that, distance traveled was positively correlated with lower-leg explosive power (Castagna et al., 2009).

Over the years, a large amount of research has been done to define the differences in the strength of explosive power of the lower extremities (Ciacci & Bartolomei, 2018; Ferioli et al., 2018; Floría & Harrison, 2013; Gonzalo-Skok et al., 2017; Kons et al., 2018; Latorre-Román, Carrasco-López, Consuegra-González, Párraga-Montilla, García-Pinillos, 2019). Two different vertical jump types have received a lot of scientific attention (Lindberg et al., 2021). It is generally accepted that the counter (CMJ) is a cycle of muscle shortening and stretching, while the squat jump (SJ) is only a shortening of the muscle. A method of measuring the explosive power of the lower extremities, the vertical jump has received significant interest in studies on the population of basketball players (Ziv & Lidor, 2010). It is well established that subjects are able to jump higher from the squat than from the squat (Bobbert et al., 1996; Van Hooren & Zolotarjova, 2017). Joint moments were also higher at the initial phase of joint extension during CMJ, allowing for the production of more work than during squat jumps (Bobbert et al., 1996). A number of recent studies have researched differences of explosive power in basketball players (Bazanov et al., 2019; Ramos et al., 2019, 2020; Wierike et al., 2015). Castagna et al. (2009) have explored that in amateur regional league basketball, there was no significant difference between senior and junior players in terms of explosive strength.

There are a limited number of studies that have evaluated the strength of the muscles of the lower extremities concerning the competitive age level in basketball. The purpose of this research is to examine whether there are any differences in the explosive power of the lower extremities among basketball players in the different age competition categories.

METHODS

Forty-one young basketball players participated in the study. Descriptive statistics of the subjects were presented in Table 1. All athletes were in healthy physical condition and had no visible or reported injuries or disabilities. The study was approved by the Faculty's Human Ethics Committee in accordance with the declaration of Helsinki. All participants volunteered and signed an informed consent document prior to testing by their parents.

Table 1. *Descriptive statistics of the subjects*

Klub	U18[a]			U16[b]			U14[c]		
	Height (cm)	Weight (kg)	Age (y)	Height (cm)	Weight (kg)	Age (y)	Height (cm)	Weight (kg)	Age (y)
N	14	14	14	13	13	13	14	14	14
Mean	1.85	80.2	17.2	1.79	67.8	15.4	1.72	56.4	13.2
Std. Deviation	0.04	10.71	0.64	0.06	7.40	0.63	0.12	14.11	0.53

Procedures

The people arrived for testing in groups of 4 to 6 at the beginning of their training term at the institution. The testing sessions started with a thorough explanation of the testing method before the real evaluation proceeded. Hands of the subject are placed on his hips. The subject begins in an upright stance for the counter movement jump. It is crucial that the subject executes a push-off action, a swiftly connected countermovement. Each subject chose the amount of knee flexion during each CMJ, keeping in mind that skilled jumpers frequently chose the amount that maximized both peak force and peak velocity, resulting in maximum power output (Klavora, 2000). To make the highest jump in the quickest amount of time, the jump must be executed as swiftly and explosively as feasible. Participants were familiar with the test protocol the day prior testing. All athletes completed a 10-minute warm-up regimen that included running drills, stretches, and muscle activation. The highest result from three CMJ trials that were measured was used in further research. The values for vertical jump were obtained using a force plate (Kistler, Quatro jump, type 9290DD). The MARS Software (Kistler, Winterthur, Switzerland) was used to record the trials since it provides quick and accurate results (Hébert-Losier & Beaven, 2014)

Statistical analyses

The ANOVA method was used to examine different arithmetic means in the parameters of the vertical jump, and then with the post hoc (Post Hoc) test, in the variants where significant differences were obtained, it was determined which pairs of groups contributed to that difference. Descriptive statistics with measures of central tendency and variation are also presented. The results are tabulated. For statistical analysis, he used the statistical package SPSS ver. 24.

RESULTS

Research results are presented which were processed using appropriate statistical techniques and the significant findings are presented in the following tables. In order to conduct parametric statistics and determine the differences in arithmetic means using ANOVA, it was necessary to determine the type of distribution of the data. This was done using the Kolmogorov Smirnov test, which we see in Table 2. The distributions of data for all variables that represented the parameters of the countermovement jump were normally distributed (do not deviate significantly from the normal distribution, $p \geq .05$).

Table 2. *Kolmogorov-Smirnov test*

	Kolmogorov-Smirnov Z	Asymp. Sig. (2-tailed)
Jump height from flight time	.79	.56
Relative maximal force	.40	1.00
Relative maximal power	.62	.83
Relative energy	1.05	.22
Jump time	.73	.67
Counter movement time	1.25	.09
Push-off time	1.45	.05

After determining the distribution of the data, the data were processed by univariate analysis of variance ANOVA in order to determine the differences between age categories of basketball players. Descriptive statistics values, arithmetic mean and standard deviation are also shown (Table 3).

Table 3. *Univariate analysis of variance with descriptive values*

Variable	Category	N	Mean	Std. Deviation	F	P
Jump height from flight time	U18	14	0.25a	0.44	3.53	.04
	U16	13	0.25a	0.41		
	U14	14	0.20b	0.19		
Relative maximal force	U18	14	229.68a	21.68	6.99	.00
	U16	13	219.05a	13.50		
	U14	14	205.90b	13.87		
Relative maximal power	U18	14	45.18	5.62	1.08	.35
	U16	13	41.90	6.02		
	U14	14	42.89	6.23		
Relative energy	U18	14	6.84	1.19	2.06	.14
	U16	13	6.35	0.88		
	U14	14	7.45	1.94		
Jump time	U18	14	0.92	0.16	.25	.78
	U16	13	0.88	0.11		
	U14	14	0.89	0.16		
Counter movement time	U18	14	0.62	0.13	1.43	.25
	U16	13	0.59	0.11		
	U14	14	0.51	0.24		
Push-off time	U18	14	0.30a	0.05	5.12	.01
	U16	13	0.29a	0.02		
	U14	14	0.37b	0.12		

$p < .05$; a,b: Different letter represents difference between groups

Based on the table of univariate analysis of variance, it can be concluded that the arithmetic means of the three parameters of the countermovement jump are statistically significantly different between age categories of basketball players: jump height from flight time (JHFT), relative maximal force (RMF) and push-off time (POT), (0.04, 0.00, 0.01 respectively). The other parameters did not show significant differences, so we can conclude that the tested categories in terms

of relative maximal power (RMP), relative energy (RE), jump time (JT), and counter movement time (CMT) do not differ significantly. Additionally, post hoc (Post Hoc LSD), analysis of parameters that differ statistically significantly in age categories, determined which pairs of categories contribute to that difference. The values of these differences are shown in lowercase letters that follow the arithmetic mean.

DISCUSSION

The aim of this research was to determine differences in the explosive power of lower limbs between basketball players of different age categories. Results showed a difference only in JHFT, RMF and POT parameters of a vertical jump.

The countermovement jump (CMJ) test is a measurement of vertical jump ability that is frequently used to evaluate athletic performance (Halson, 2014). Our results yielded that the youngest category of basketball players contributed a significant difference in JHFT between groups. In contrast to our results, Castagna et al. (2009) showed no significant difference in explosive power between senior and junior basketball players.

It can be noted that for all three variables (JHFT, RMF and POT) representing vertical jump parameters, participants from the U14 category contribute to the difference between categories of basketball players, while respondents from the U18 and U16 categories do not statistically significantly differ. This can be interpreted in several ways. One of them is certainly sports experience as well as the ability to correctly perform the countermovement jump technique. Maximum force as well as push-off time are directly related to jumping height. Considering that U14 category are with the lowest muscular potential of the lower limbs, due to a specific period of development, the difference can be attributed to this factor as well. Regarding the anthropometric characteristics of weight and height, as well as years of age, the previous analysis, Table 1, showed that the categories differ statistically significantly from each other, so this cannot be a factor of difference only among U14 category

CONCLUSION

Based on the conducted research, it can be concluded that the main vertical jump parameters, JHFT, RMF and POT differ significantly between the three age categories of basketball players.

REFERENCES

Bazanov, B., Pedak, K., & Rannama, I. (2019). *Relationship between musculoskeletal state and vertical jump ability of young basketball players.* https://doi.org/10.14198/JHSE.2019.14.PROC4.33

Bobbert, M. F., Gerritsen, K. G. M., Litjens, M. C. A., & Van Soest, A. J. (1996). Why is countermovement jump height greater than squat jump height? *Medicine and Science in Sports and Exercise,* 28(11), 1402–1412. https://doi.org/10.1097/00005768-199611000-00009

Calleja-González, J., Terrados, N., Mielgo-Ayuso, J., Delextrat, A., Jukic, I., Vaquera, A., Torres, L., Schelling, X., Stojanovic, M., & Ostojic, S. M. (2016). Evidence-based post-exercise recovery strategies in basketball. *The Physician and Sportsmedicine*, 44(1), 74–78. https://doi.org/10.1080/00913847.2016.1102033

Castagna, C., Chaouachi, A., Rampinini, E., Chamari, K., & Impellizzeri, F. (2009). Aerobic and explosive power performance of elite italian regional-level basketball players. *Journal of Strength and Conditioning Research*, 23(7), 1982–1987. https://doi.org/10.1519/JSC.0B013E3181B7F941

Ciacci, S., & Bartolomei, S. (2018). The effects of two different explosive strength training programs on vertical jump performance in basketball. *The Journal of Sports Medicine and Physical Fitness,* 58(10), 1375–1382. https://doi.org/10.23736/S0022-4707.17.07316-9

Ferioli, D., Rampinini, E., Bosio, A., La Torre, A., Azzolini, M., & Coutts, A. J. (2018). The physical profile of adult male basketball players: Differences between competitive levels and playing positions. *Journal of Sports Sciences*, 36(22), 2567–2574. https://doi.org/10.1080/02640414.2018.1469241

Floría, P., & Harrison, A. J. (2013). Ground reaction force differences in the countermovement jump in girls with different levels of performance. *Research Quarterly for Exercise and Sport*, 84(3), 329–335. https://doi.org/10.1080/02701367.2013.813896

Gonzalo-Skok, O., Serna, J., Rhea, M. R., & Marín, P. J. (2017). AGE DIFFERENCES IN MEASURES OF FUNCTIONAL MOVEMENT AND PERFORMANCE IN HIGHLY YOUTH BASKETBALL PLAYERS. *International Journal of Sports Physical Therapy*, 12(5), 812–821. https://doi.org/10.26603/ijspt20170812

Halson, S. L. (2014). Monitoring Training Load to Understand Fatigue in Athletes. S*ports Medicine (Auckland, N.Z.)*, 44(Suppl 2), 139. https://doi.org/10.1007/S40279-014-0253-Z

Hébert-Losier, K., & Beaven, C. M. (2014). The mars for squat, countermovement, and standing long jump performance analyses: Are measures reproducible? *Journal of Strength and Conditioning Research*, 28(7). https://doi.org/10.1519/JSC.0000000000000343

Klavora, P. P. (2000). *Vertical-jump Tests: A Critical Review: Strength & Conditioning Journal. STRENGTH AND CONDITIONING JOURNAL.* https://journals.lww.com/nsca-scj/citation/2000/10000/vertical_jump_tests__a_critical_review.20.aspx

Kons, R. L., Ache-Dias, J., Detanico, D., Barth, J., & Dal Pupo, J. (2018). Is Vertical Jump Height an Indicator of Athletes' Power Output in Different Sport Modalities? *Journal of Strength and Conditioning Research*, 32(3), 708–715. https://doi.org/10.1519/JSC.0000000000001817

Latorre-Román, Carrasco-López, Consuegra-González, Párraga-Montilla, García-Pinillos, S.-S. (2019). *Strength differences between trained and untrained pre-pubertal children: Stretch-shortening cycle of muscle contractions*. https://repositorio.uautonoma.cl/handle/20.500.12728/5058

Lindberg, K., Solberg, P., Bjørnsen, T., Helland, C., Rønnestad, B., Frank, M. T., Haugen, T., Østerås, S., Kristoffersen, M., Midttun, M., Sæland, F., & Paulsen, G. (2021). Force-velocity profiling in athletes: Reliability and agreement across methods. *PloS One,* 16(2). https://doi.org/10.1371/JOURNAL.PONE.0245791

Ramos, S., Volossovitch, A., Ferreira, A. P., Barrigas, C., Fragoso, I., Massuca, L., & Massuça, L. (2020). Differences in Maturity, Morphological, and Fitness Attributes Between the Better- and Lower-Ranked Male and Female U-14 Portuguese Elite Regional Basketball Teams. *Journal of Strength and Conditioning Research*, 34(3), 878–887. https://doi.org/10.1519/JSC.0000000000002691

Ramos, S., Volossovitch, A., Ferreira, A. P., Fragoso, I., & Massuça, L. (2019). Differences in maturity, morphological and physical attributes between players selected to the primary and secondary teams of a Portuguese Basketball elite academy. *Journal of Sports Sciences,* 37(15). https://doi.org/10.1080/02640414.2019.1585410

Stojanović, E., Stojiljković, N., Scanlan, A. T., Dalbo, V. J., Berkelmans, D. M., & Milanović, Z. (2018). The Activity Demands and Physiological Responses Encountered During Basketball Match-Play: A Systematic Review. *Sports Medicine,* 48(1), 111–135. https://doi.org/10.1007/s40279-017-0794-z

te Wierike, S. C. M., Elferink-Gemser, M. T., Tromp, E. J. Y., Vaeyens, R., & Visscher, C. (2015). Role of maturity timing in selection procedures and in the specialisation of playing positions in youth basketball. *Journal of Sports Sciences,* 33(4). https://doi.org/10.1080/02640414.2014.942684

Van Hooren, B., & Zolotarjova, J. (2017). The Difference Between Countermovement and Squat Jump Performances: A Review of Underlying Mechanisms With Practical Applications. *Journal of Strength and Conditioning Research,* 31(7), 2011–2020. https://doi.org/10.1519/JSC.0000000000001913

Ziv, G., & Lidor, R. (2010). Vertical jump in female and male basketball players--a review of observational and experimental studies. *Journal of Science and Medicine in Sport,* 13(3), 332–339. https://doi.org/10.1016/J.JSAMS.2009.02.009

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DIFFERENCES IN THE MOTOR ABILITIES AND ANTHROPOMETRIC CHARACTERISTICS OF YOUTH FOOTBALL AND BASKETBALL PLAYERS

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ABSTRACT

Enhancing motor skills has a significant impact on athletes' field performance. Both sports depend on a combination of highlevels of physical, technical, and tactical ability. The aim of this study was to examine the differences in the motor abilities and anthropometric characteristics of the football and basketball players aged 13-15 years. Thirty-six participants were divided in two groups (football players, (n=18; height:1.71 ± 8.5m; body mass: 20.1± 2.2 kg; age: 14.7 ± 0.3 years) and basketball players, n=18; height: 1.69± 10.9; body mass 3.4 ±20.6; age:0.7 ±14.1) aged 13-15 years old. Conducted motor abilities were 10m and 20m sprint, agility t-test, countermovement jump (CMJ), countermovement jump with arm swing (CMJa) and squat jump (SJ), while anthropometric characteristics were fat percentage, body mass index, muscle percentage, height, weight. Independent sample T-test revealed statistical significance only in fat percentage (p=.003), muscle percentage (p=.002), agility (p=.000), and sprint (p=.000), while in the countermovement jump, countermovement jump with arm swing, squat jump, body mass index, height, and weight, there were no statistical significance. Athletes who play different sports have performed different results in agility test, speed test, fat percentage and muscle percentage. Football players achieved better results compared to basketball players, which is due to the character of the game, where players move within a wider space, as well as the different structure of the training process.

Keywords: *explosive strength, speed, physical performance, morphological characteristics, team sport*

INTRODUCTION

Football and basketball are the most played sports around the world. Both sports depend on a combination of high levels of physical, technical, and tactical ability (Guimarães et al., 2019). Football is one of the most popular sports worldwide with 4% of the world's population actively involved, including 21.5 million young players under the age of 18 who practice soccer. Soccer is a high-intensity sport that involves motor skills that require aerobic and anaerobic power, including motor skills such as agility, speed, strength, and endurance (Little & Williams, 2003). Football is one of the most complete sports in terms of a large number of different movements, and can be classified as a complex semi-structural sport (Gardasevic & Bjelica, 2020).

Basketball is a team sport that involves high-intensity running, acceleration, deceleration, sprints, constant changes of direction, jumping and other technical skills (Ben Abdelkrim et al., 2010). Basketball is a popular team sport and is a mix of casual and high-intensity activities (McKeag, 2008). In addition, it is a sport with a lot of contacts and sometimes an aggressive approach. Although it is a team sport, the individual quality of the athletes can decide the winner of the match in most situations. Strength is known to be an ability that helps us overcome resistance and is important in almost every sport, especially contact sports. The dominant type of strength used in the game of basketball is explosive strength, whether it's for shooting at the hoop or running past opponents. Motor abilities such as jumping and agility are most often represented in the basketball game (Vukasevic et al., 2020). Assessment of strength performance in basketball players is performed through the vertical jump and vertical jump tests (Cole et al., 2020). As the most frequently repeated motor ability, vertical jumps occur every minute in a basketball game (Stojanović et al., 2018).

The aim of this research was to determine the differences in motor skills and anthropometric characteristics of football and basketball players aged 13-15.

METHODS

Subjects

Thirty-six participants were divided in two groups (football players, (n=18; height:1.71 ± 8.5m; body mass: 20.1 ± 2.2 kg; age: 14.7 ± 0.3 years) and bas-

ketball players, n=18; height: 1.69 ± 10.9; body mass 20.6 ± 3.4; age:14.1 ± 0.7) aged 13-15 years old. Before the test, the parents of the subjects were informed about the protocol and gave their voluntary consent to participate in the research. The subjects were in good sports shape and had excellent health status before and during the testing.

Procedure

The testing was held in the morning hours on the auxiliary field of the football club Radnički with a temperature of around 23°S. First, the anthropological measurements of the subjects were taken, and then there was a 20-minute warm-up consisting of running and shaping exercises as well as games on a reduced field to bring the body of the subjects to an adequate level of preparedness for the test. Testing of basketball players was held in the morning hours at Ratko Vukićević elementary school. First, the subjects' anthropological measurements were taken, followed by a 20-minute warm-up consisting of running and shaping exercises as well as games on a reduced basketball court, in order to prepare them for testing.

Anthropometric characteristics

Martin's anthropometer GPM 101 (GPM GmbH Switzerland) was used to assess body height with an accuracy of 0.1 cm. The subjects stood in an upright position, barefoot on a solid surface, feet together, the measurer makes sure that the anthropometer is in a vertical position along the back of the body, and then lowered the sliding compass of the anthropometer to the top of the subject's head, the reading is made on the upper opening along the line that is the reading indicator.

Body mass index, body mass, muscle percentage, and fat percentage were collected using a bioelectrical impedance (Vasold et al.2018) Omron BF511 (Omron Healthcare Co, Kyoto, Japan) with an accuracy of 0.1 kg. It is measured by the meter entering information about the subject about age, gender, and height. The subjects were barefoot on the instrument with underwear on and hands in front, at shoulder height, holding a piece of bioelectrical impedance.

Agility test

Agility were assessed using the t-test. The reliability and validity of the test was confirmed in the study (Pauole et al.2000). Subjects repeated three times, and the fastest time on agility tests was taken into further statistical data analysis. Agility assessment was performed with a photocell system (Witty, System, Microgate, Bolzano, Italy), and the entire testing procedure was in accordance with the guidelines given in earlier studies.

Speed test

Speed assessment was performed in 10m and 20m sprints. The speed was evaluated using a photocell system (Witty, System, Microgate, Bolzano, Italy). At the signal of the meter, they start and pass through the gates as fast as they can without stopping.

Statistical analysis

Data processing was performed with the IBM SPSS statistics program (version 26.0; Inc., Chicago, IL, USA). The normality of the data distribution was checked with the Kolmogorov-Smirnov test for all independent variables, while the T-test for two independent groups was used to determine the differences in motor abilities and anthropological characteristics of football and basketball players.

RESULTS

Table 1 shows the mean value and standard deviation of the following t-test parameters, height, weight, fat percentage, muscle percentage, countermovement jump with arm swing, squat jump, and speed at 10m and 20m.

Table 1. *Results of descriptive statistics*

	N	Mean	Std. Deviation
Height_	36	170.63	9.71
Weight_F	36	59.77	13.23
BMI_F	36	20.36	2.84
%Fat_F	36	13.17	5.45
%Muscle_F	36	40.65	2.51
t-test_F	36	11.23	1.10
CMJ_F	36	28.25	4.39
CMJwas_F	36	34.61	5.79
SJ_F	36	26.10	4.29
10m_F	36	1.99	.17
20m_F	36	3.46	.31

Table 2.*Results of descriptive individual statistics*

Sport		N	Mean	Std. Deviation
1	Height_F	18	171.73	8.53
	Weight_F	18	59.60	10.29
	BMI_F	18	20.12	2.23
	%Fat_F	18	10.60	2.87
	%Muscle_F	18	41.93	1.42
	t-test_F	18	10.37	.73
	CMJ_F	18	28.47	3.43
	CMJwas_F	18	36.26	4.67
	SJ_F	18	26.65	3.76
	10m_F	18	1.89	.12
	20m_F	18	3.24	.19
	Valid N (listwise)	18		
2	Height_K	18	169.52	10.90
	Weight_K	18	59.94	15.96
	BMI_K	18	20.61	3.39
	%Fat_K	18	15.75	6.25
	%Muscle_K	18	39.37	2.73
	t-test_K	18	12.10	.62
	CMJ_K	18	28.03	5.27
	CMJwas_K	18	32.96	6.44
	SJ_K	18	25.56	4.81
	10m_K	18	2.09	.16
	20m_K	18	3.68	.25
	Valid N (listwise)	18		

Table 3. *T-test for independent samples*

Variables	Sig.
Height	**.504**
Weight	**.939**
BMI	**.617**
Fat percentage	**.003**
Muscle percentage	**.002**
T-тест	**.000**
CMJ	**.770**
CMJwas	**.087**
SJ	**.455**
10m sprint	**.000**
20m sprint	**.000**

Table 3 shows the results of the t-test for independent samples with statistical significance for the variables fat percentage, muscle percentage, t-test, 10m sprint, and 20m sprint.

DISCUSSION

The goal of this research was to determine whether there are differences in motor skills and anthropometric characteristics of football and basketball players. The results showed that there are statistically significant differences in fat percentage, muscle percentage, t-test, 10m sprint, and 20m sprint.

The T-test is a reliable and valid measure of leg speed as well as leg strength and agility (Pauole et al., 2000). Our results showed a statistically significant difference in the values of the t-test that evaluates agility between the tested basketball players and football players. The results showed that the football players had a better time on the agility test by 1.73 seconds. There are similarities in the results of our study with the results of (Kariyawasam et al., 2019), showing better results in football players than in basketball players in the pro agility test. These results can be explained by the fact that football players have a significantly different body compositions, and because of this, there is a big difference in agility tests.

A vertical jump assessment test such as the squat jump has shown high absolute and relative reliability in basketball and football players (Rodríguez-Rosell et al., 2017). Regarding our study that did not show statistical significance in the squat jump, a study by Theoharopoulos et al.(2009) showed different results. Football players had better performance than basketball players in the vertical jumps in the squat jump test at the age of 14-15 years. Contrary to the previous study, the authors Kariyawasam et al.(2019) showed that basketball players had better results than football players in the squat jump. Squat jump It is known that basketball players have significantly more frequent jumps during basketball games and during the training process, it is expected that basketball players have statistically significantly higher vertical jump, however, our results as well as the results of other studies showed variability, which can be related to the age of the subjects or by a sample of respondents who are not at a high level of training.

Speed in football includes both physical and perceptual-cognitive components (Paul et al., 2016). Our study showed that football players achieved better speed results in 10m and 20m sprints compared to basketball players, which is conditioned by the nature of the game, where players move within a wider space, as well as the different structures of the training process. Šimonek et al. (2017) also showed that football players were faster than basketball players, which is again conditioned by body composition and a different training process.

Our study is limited by the sample of respondents, a larger number of participants could generalize the obtained results to the population. Also one of the limitations of the study could be the different raters that measured basketball and football players in particular. As well as a sample of respondents who are not at the professional level of the competition.

CONCLUSION

This study showed that football players are better than basketball players in tests of agility, speed, and

percentage of fat and muscle in younger categories. Explosive power is not greater in a group of basketball players, this can be a guideline for coaches to focus their training on developing explosive power as one of the more important motor skills in basketball.

REFERENCES

Ben Abdelkrim, N., Castagna, C., El Fazaa, S., & El Ati, J. (2010). The effect of players' standard and tactical strategy on game demands in men's basketball. *Journal of Strength and Conditioning Research*, 24(10), 2652–2662. https://doi.org/10.1519/JSC.0B013E3181E2E0A3

Gardasevic, J., & Bjelica, D. (2020). Body Composition Differences between Football Players of the Three Top Football Clubs. *International Journal of Morphology*, 38(1).

Guimarães, E., Baxter-Jones, A., Maia, J., Fonseca, P., Santos, A., Santos, E., Tavares, F., & Janeira, M. A. (2019). The Roles of Growth, Maturation, Physical Fitness, and Technical Skills on Selection for a Portuguese Under-14 Years Basketball Team. *Sports* (Basel, Switzerland), 7(3). https://doi.org/10.3390/SPORTS7030061

Kariyawasam, A., Ariyasinghe, A., Rajaratnam, A., & Subasinghe, P. (2019). Comparative study on skill and health related physical fitness characteristics between national basketball and football players in Sri Lanka. *BMC Research Notes*, 12(1). https://doi.org/10.1186/S13104-019-4434-6

Little, T., & Williams, A. (2003). *Specificity of acceleration, maximum speed and agility in professional soccer players* (pp. pp-144). Routledge: London, UK.

McKeag, D. B. (2008). *Handbook of Sports Medicine and Science: Basketball. Handbook of Sports Medicine and Science: Basketball*, 1–225. https://doi.org/10.1002/9780470693896

Paul, D. J., Gabbett, T. J., & Nassis, G. P. (2016). Agility in Team Sports: Testing, Training and Factors Affecting Performance. *Sports Medicine*, 46(3), 421–442. https://doi.org/10.1007/S40279-015-0428-2

Pauole, K., Madole, K., Garhammer, J., Lacourse, M., & Rozenek, R. (2000). Reliability and Validity of the T-Test as a Measure of Agility, Leg Power, and Leg Speed in College-Aged Men and Women. *Journal of Strength and Conditioning Research*, 14(4), 443–450. https://doi.org/10.1519/00124278-200011000-00012

Rodríguez-Rosell, D., Mora-Custodio, R., Franco-Márquez, F., Yáñez-García, J. M., & González-Badillo, J. J. (2017). Traditional vs. Sport-specific vertical jump tests: Reliability, validity, and relationship with the legs strength and sprint performance in adult and teen soccer and basketball players. *Journal of Strength and Conditioning Research*, 31(1), 196–206. https://doi.org/10.1519/JSC.0000000000001476

Šimonek, J., Horička, P., & Hianik, J. (2017). The differences in acceleration, maximal speed and agility between soccer, basketball, volleyball and handball players. *Journal of Human Sport and Exercise*, 12(1), 73–82. https://doi.org/10.14198/JHSE.2017.121.06

Stojanović, E., Stojiljković, N., Scanlan, A. T., Dalbo, V. J., Berkelmans, D. M., & Milanović, Z. (2018). The Activity Demands and Physiological Responses Encountered During Basketball Match-Play: A Systematic Review. *Sports Medicine*, 48(1), 111–135. https://doi.org/10.1007/s40279-017-0794-z

Theoharopoulos A., Garefis A., Galazoulas Ch., T. G. (n.d.). *A Comparative Study for Flexibility and Jumping Ability Between Young Basketball and Soccer Players*. Retrieved 12 September 2022, from https://ejmas.com/pt/2009pt/ptart_galazoulas_0912.html

Vasold, K. L., Parks, A. C., Phelan, D. M. L., Pontifex, M. B., & Pivarnik, J. M. (2019). Reliability and validity of commercially available low-cost bioelectrical impedance analysis. *International Journal of Sports Nutrition and Exercise Metabolism*, 29(4), 406–410. https://doi.org/10.1123/IJSNEM.2018-0283

Vukasevic, V., Mitrovic, M., & Masanovic, B. (2020). A comparative study of motor ability between elite basketball players from different regions. *Sport Mont*, 18(1), 3–7. https://doi.org/10.26773/smj.200201

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AGE-SPECIFIC FEATURES OF THE MAXIMUM ALACTATE POWER OF HIGHLY SKILLED HOCKEY PLAYERS (FIELD HOCKEY)

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ABSTRACT
Objective: to study the long-term dynamics of peak power and anaerobic capacity (PP&AnC) and its relationship with the athlete's age. Materials and methods. The research was conducted on the example of elite field hockey players n=11, who were regularly tested for 14 years. Initial mean study age 19.0±4.31 final mean study age 31.8±4.89. We obtained data on the long-term dynamics of the PP&AnC index, which characterizes the power of the speed and strength training of the lower limb muscles. To evaluate this index in laboratory studies, we used the Wingate Anaerobic Test (WAnT) modified in the Moscow Institute of Physics and Technology (MIPT) laboratory. Results. On the results of regression and correlation analyses, we obtained significant data (p < .01) on the increase of PP&AnC indexes with the age of all researched hockey players. Conclusion. On the example of the obtained data, coaches of other playing sports can take into account the PP&AnC indicator when forming teams in the Olympic cycle. The PP&AnC index tends to increase with age in highly skilled athletes, which is proven by the standard of the WAnT over 14 years.

Keywords: *Field hockey, Maximum alactate power (MAP), Peak Power and Anaerobic Capacity (PP&AnC), Wingate anaerobic Test (WAnT).*

INTRODUCTION

Many authors express a competent opinion that achieving high sports results in elite sports is possible only after systematic, consistent, and methodically justified training work in childhood and adolescence (Antonov, 2006, Antonov, 2019, Dimitrieska, Antonov, 2013, Farfel, 1975, Guzhalovsky, 1986). In their publications, the authors have shown that different organs and systems of the body form and develop throughout human life in a non-simultaneous and uneven manner. Yakimovich (2006) emphasized the age of athletes and their sports achievements in the Olympic Games. So the number of Olympic champions and medalists aged 35 and older for women and 40 years for men in summer sports significantly exceeds their number in winter sports. Water polo, handball, and field hockey were included in the statistics of age Olympians in game sports, where the number of such Olympic long-livers was minimal, from 1 to 5 athletes (Yakimovich, 2006). Thus, Olympic awards were won by older athletes not only in individual sports but also in game sports. For example, the average age of the 2016 Olympic field hockey champions for the British women's national team was 32.5±3.9; V=12.1% (NEWSru 2016).

In most competitive sports, it is the display of functional ability that is required to achieve high results: maximal muscular power and anaerobic capacity, maximum oxygen consumption at aerobic and anaerobic thresholds, and other indices (Zaborova et al., 2011, Zaharova, Berdinikov, 2016, Seluyanov et al., 2012). The Wingate Anaerobic Test (WAnT) is widely used to investigate the maximal muscular power and anaerobic capacity in sports practice (Berdinikov et al., 2017, Chikov et al., 2018, Delisle-Houde, 2018, Green et al., 2006, Golovachev et al., 202, Yakimovich, 2006). In the literature, there are data of comparative analysis of the results of Wingate-testing in athletes of some individual sports (Mehdieva, 2021), mini-football players with high qualifications (Berdnikov et al., 2017), soccer players with different qualifications (Seluyanov et al., 2012), hockey players (Delisle-Houde, 2018, Green et al., 2006), pentathletes athletes (Zaborova et al., 2011). Longer studies were conducted on women's ski sprints at different stages of the annual and Olympic training cycle (Zakharova, Berdnikov, 2016). Studies of the dynamics of the athlete's speed-power index are informative and demanded by coaches throughout the entire yearly training cycle. The age of the athlete must be taken into account. Objective: to study the long-term dynamics of PP&AnC as the main indicator of speed and strength training of hockey players and to reveal its interrelation with the age of athletes.

METHODOLOGY

Participants

Between 2004 and 2017, there were 19 comprehensive laboratory examinations involving 80 highly skilled hockey players. All the hockey players represented the same club. Not all 80 hockey players have undergone 19 comprehensive examinations. Only 11 players who participated in at least 10 studies over 6-14 years were selected. Eight of the 11 players were on the national field hockey team. The study involved 11 elite Russian hockey players (age = 19,0 ± 4.31 years, weight = 70.75 ± 9.33 kg, height = 175.6 ± 6.23 cm) at the initial study. At the end of the study, the characteristics of hockey players were as follows (age =31.8 ± 4.89 years, weight = 79.1 ± 8.42 kg, height = 178.4 ± 5.80 cm). Subject characteristics measured at baseline are presented in Table 1. The parents of the researched participants were informed about the study, and they gave their informed consent for the participation of their children.

Table 1. *Baseline characteristics of the hockey players at the beginning and end of the study*

N	Playing role	Initial study			Final study			Survey period (years)	Number of examinations (number of times)
		Age	Weight kg	Growth sm	Age	Weight kg	Growth sm		
1	Defender	17	84.0	180	29	79.5	180	12	18
2	Defender	17	58.8	169	30	83.2	183	13	17
3	Midfielder	17	67.0	173	30	77.8	175	13	16
4	Defender	20	71.0	170	34	70.0	172	13	15
5	Forward	18	86.6	186	32	99.8	186	13	14
6	Defender	16	70.8	170	29	72.6	170	13	14
7	Midfielder	20	73.8	170	34	74.5	171	13	12
8	Defender	15	60.0	174	25	74.2	179	11	11
9	Forward	30	76.9	186	43	86.6	187	7	10
10	Forward	23	69.8	176	36	78.8	180	7	10
11	Forward	16	59.6	178	27	73.1	179	6	10
M		19.0	70.75	175.6	31.72	79.1	178.4	11.0	13.4
σ		4.31	9.33	6.23	4.94	8.42	5.80	2.86	2.94
V%		27.7	13.2	3.6	15.6	10.6	3.3	26.0	22.0

The tests were conducted at various stages of the one-year training cycle. The standard of research over 14 years was fully respected in the laboratory Moscow Institute of Physics and Technology (MIPT).

The Wingate Anaerobic Test immediately followed the jump assessments. The bike seat was adjusted to preference and participants engaged in a 5-minute standardized warm-up. To begin the test, participants pedaled as fast as possible until 180 revolutions per minute were reached. At this point, the added weight (9% of body weight) was dropped on the bike, and participants were verbally encouraged to continue pedaling while remaining seated (3). The test lasted 30 seconds, and after, each participant was encouraged to continue pedaling for a 2-minute cool-down period. From this test, relative peak power (W·kg–1), relative mean power (W·kg–1), and fatigue index (% drop) were obtained. Peak power was the highest output achieved in the test, mean power was the average output across the 30 seconds, and fatigue index was how much the power output dropped throughout the test.

Subjects performed two tests in succession. The first step test was performed on a Monark 894 Peak Bike ergometer. Heart rate (HR) and pulmonary ventilation (PV) were recorded. Exhaled air was analyzed on a METAMAX (Cortex, Germany). The power of aerobic and anaerobic thresholds (AET, ANT), as well as oxygen consumption (OC) and HR were assessed by changes in pulmonary ventilation rate and respiratory rate. Maximum oxygen consumption Predicted VO2max and Measured VO2max were calculated. Then, after recovery (3-5 minutes), the main test was performed to determine the PP&AnC. The subject performed sprint acceleration on the same cycle ergometer. The load for hockey players was determined taking into account their body weight: Load (Newtons) = 0.9 × body weight. The hockey player started pedaling without load, trying to

gradually increase the pace. The load was gradually increased. When the pace reached 80-90 revolutions per minute, the test subject was given the maximum load for that athlete. After that, the subject should pedal at maximum effort so that after 5-7 seconds, the maximum tempo in the 130-150 revolutions per minute range is shown. As soon as the tempo began to decrease, the test stops. At the same time, the maximum values of pace and power of pedaling were recorded, which were determined by PP&AnC.

A large amount of anthropometric data was conducted in a comprehensive study. In our article, we present only the height, weight, and WAnT data of the examined athletes.

Methods of mathematical statistics

Standard methods of statistical data processing were used: determination of sample mean (M), mean-square deviation (б) and coefficient of variation (V%). Linear regression and correlation analysis made it possible to evaluate the relationship between the parameters by calculating the Pearson correlation coefficient. All processing was carried out in an Excel spreadsheet environment. There were also built scatter diagrams, in which dependence of PP&AnC on age for each of the subjects with a calculation of regression equation of this dependence and coefficient of determination R^2.

RESULTS

The results of the linear regression analysis between the independent variable-age of each athlete (predictor) and the dependent variable – peak power and anaerobic capacity (PP&AnC, W/kg) are presented as dot plots (Figures 1-11). The dots in the figure represent the number of tests in which the athlete participated. Figures are presented sequentially as in Table 1. In parentheses next to the player's position is his age at the time of the last test.

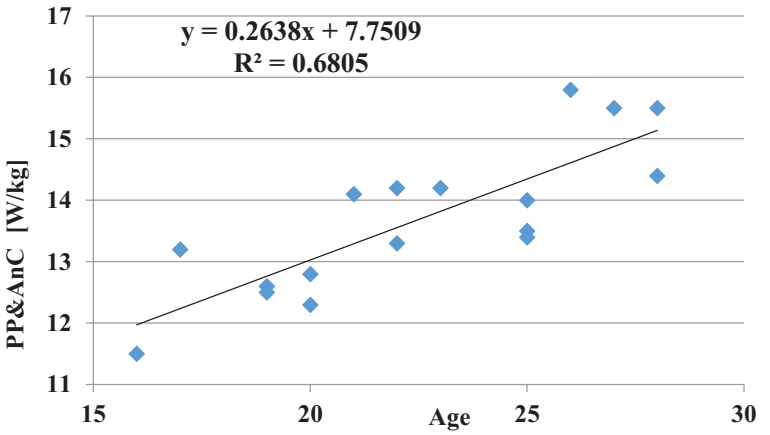

Figure 1. *Defender 1 (29)*

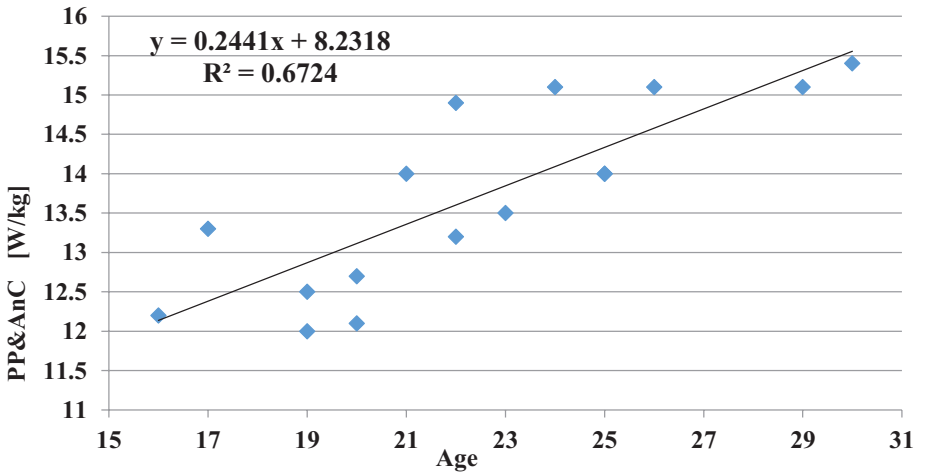

Figure 2. *Defender 2 (30)*

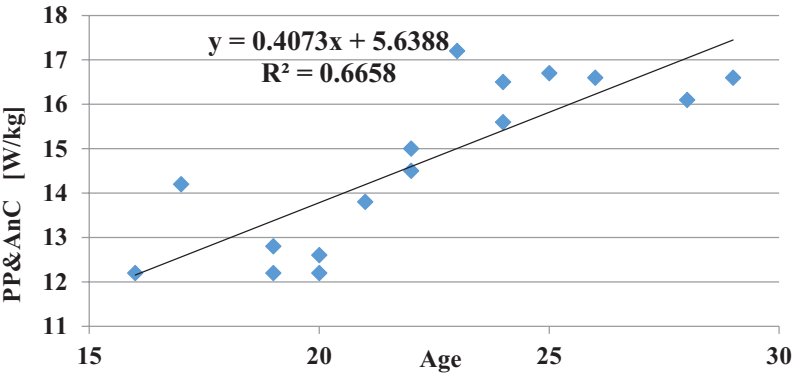

Figure 3. *Midfielder 3 (30)*

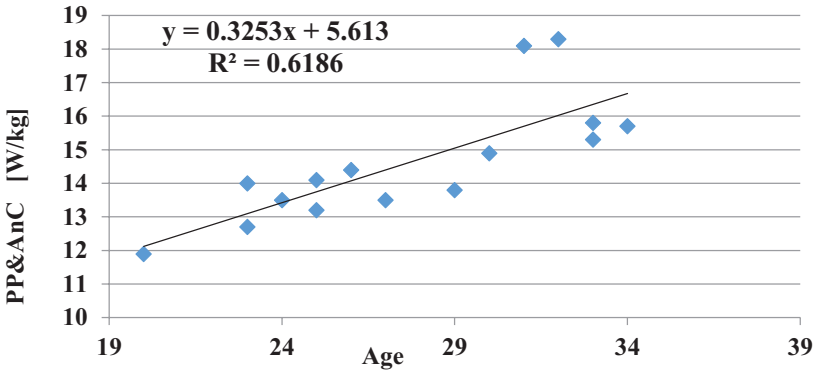

Figure 4. *Defender N4 (33)*

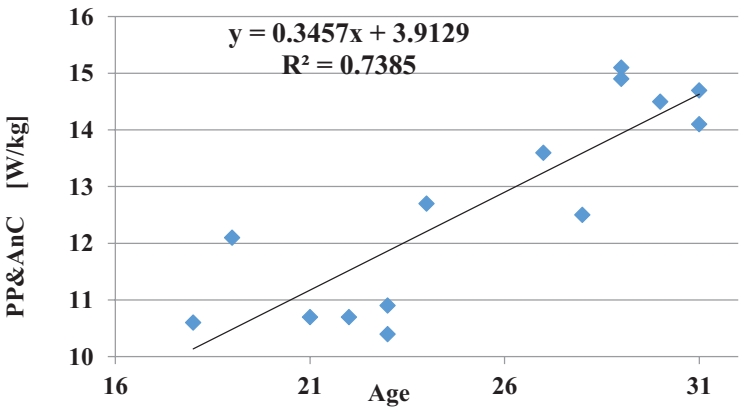

Figure 5. *Defender 5 (32)*

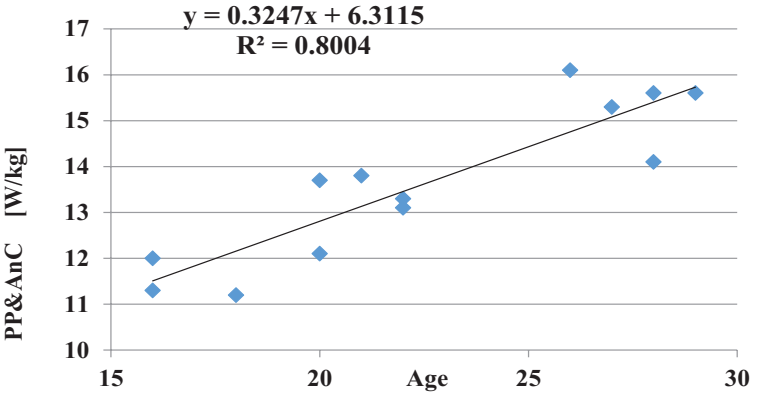

Figure 6. *Defender 6 (29)*

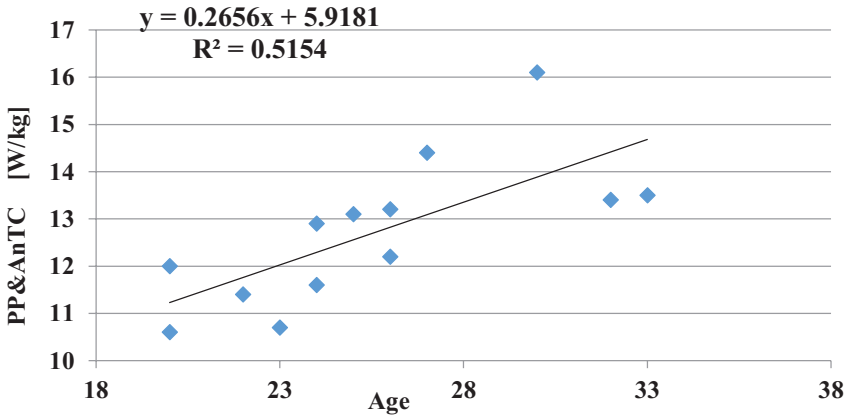

Figure 7. *Midfielder 7 (33)*

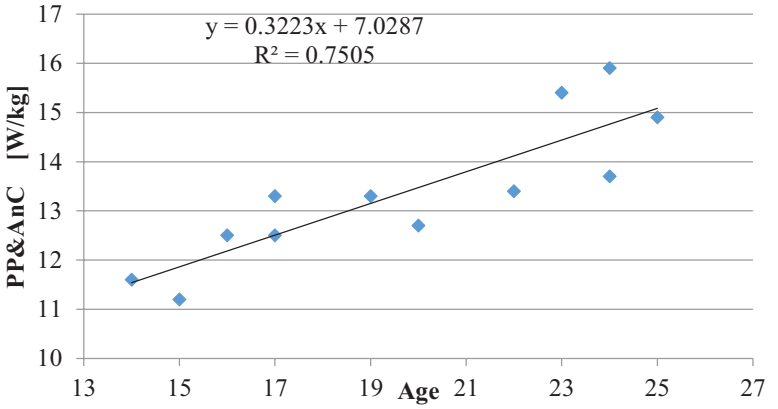

Figure 8. *Midfielder 8 (26)*

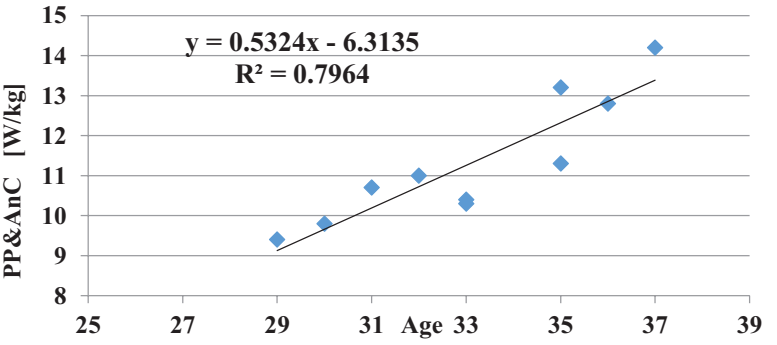

Figure 9. *Forward 9 (37)*

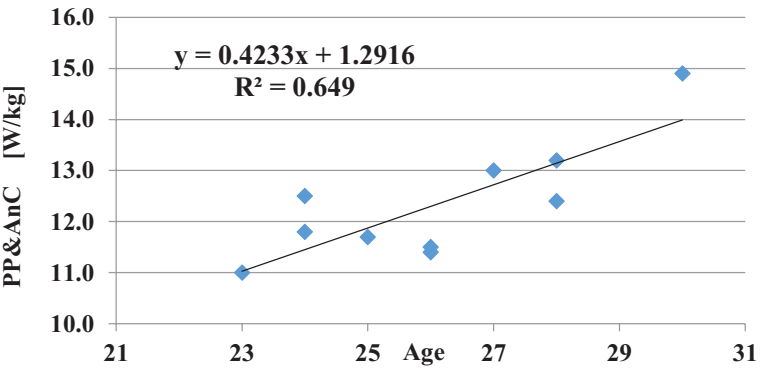

Figure 10. *Forward 10 (29)*

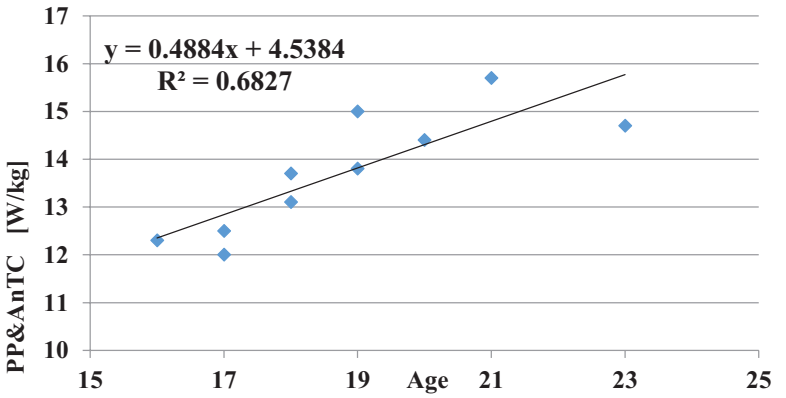

Figure 11. *Forward 11 (23)*

In all figures, we see a linear increasing trend in the values of the PP&AnC variable as the age of the athlete increases. The values of the obtained R^2 values from 0.51, (Figure 7, Midfielder 7 (33)), to 0.80 (Figure 6. Defender 6 (29)) indicate a fairly good approximation of the dependence of PP&AnC on the age of athletes. All coefficients in the linear regression equations presented are statistically significant at the $p < .05$ level or higher. The study period in both cases (Figure 6 and Figure 7) was 14 years.

DISCUSSION

These results allow us to conclude that in the process of ontogenesis in all hockey players under study the speed and strength preparedness of the muscles of the lower extremities increases. To confirm the hypothesis of the relationship between the increase in PP&AnC and the age of the hockey players, we performed a Pearson correlation analysis. The results of the correlation analysis and some statistical values are presented in Table 2.

Table 2. *Results of the correlation and regression analysis of the dependence of the alactate relative peak power on the athlete's age*

№	Playing role	Average age (year)	Athlete's age at the end of the study period (year)	Peak power & anaerobic capacity (W/kg) M± σ	Pearson's correlation coefficient	Two-way correlation. Significance at the level:	Regression coefficient R^2
1	Defender	22.9	30	13.6±1.16	**.825**	**< .01**	.680
2	Defender	25.5	30	12.7±1.53	**.820**	**< .01**	.672
3	Midfield	22.2	30	14.6±1.85	**.816**	**< .01**	.665
4	Defender	27.5	34	14.6±1.81	**.787**	**< .01**	.618
5	Forward	25.3	32	12.7±1.79	**.859**	**< .01**	.738
6	Defender	23.3	29	13.6±1.67	**.895**	**< .01**	.800
7	Midfield	25.5	34	12.7±1.53	**.718**	**< .01**	.515
8	Defender	19.7	25	13.4±1.44	**.864**	**< .01**	.751
9	Forward	33.1	43	11.3±1.58	**.892**	**< .01**	.796
10	Forward	26.1	36	12.3±1.14	**.806**	**< .01**	.649
11	Forward	18.8	27	13.7±1.24	**.864**	**< .01**	.750

The results of correlation analysis showed a close correlation between the growth dynamics of the required indicators, with a high degree of reliability $p < 0.01$ for all athletes. Age differences of the researched at the beginning of the experiment from 15 to 30 years old (Table 1) and different individual values of PP&AnC from 11.3±1.58 to 14.6±1.85 W/kg (Table 2) did not influence the dynamics of the results of speed and power abilities gain. Such a trend is debatable. As the results obtained relate only to one game sport field hockey. We found that with age the athlete increases the parameters of speed and strength training of the muscles of the lower limbs. It can be assumed that to a greater extent this refers to the strength component, due to the number of recruited muscle fibers, the number

of myofibrils, and the average ATP-ase activity of myosin in them (Zaborova et al., 2011). The values of R^2 values presented in Table 2 in a pairwise linear relationship can be interpreted as coefficients of determination, which characterize the proportion of change in one of the indicators when the other changes. Therefore, in our case, it can be argued that changes in the age of athletes by more than 0.5 (50%) determine changes in PP&AnC indices. The correct construction of the training process of athletes under the age of 40 helps to increase the peak power and anaerobic capacity index. The initial age of the investigated athletes (from 15 to 30 years), and the individual values of PP&AnC of different abilities during the first tests did not influence the subsequent dynamics of the results of speed and strength ability gain.

ACHIEVEMENTS, CONCLUSIONS AND RECOMMENDATIONS FOR PRACTICE

During the period from 2008 to 2012, 8 of the studied players fulfilled the standard of the master of sports of the Russian Federation of international class. All the guys were included in the national field hockey and indoor hockey team, showing the best results in the history of Russian hockey becoming champions (2008) and vice-champions (2010) of Europe in indoor hockey, bronze medalists in the Olympic qualifying tournament (2008) and taking a high 7th place in the European field hockey championship (2011). Functional fitness tests conducted at various stages of preparation allowed timely adjustments to the training process and distribute both individual and group loads in the club teams and the national team.

The research on the problem and the results of the research gives us the basis for formulating the following conclusions and recommendations for practice:

1. Testing of the index of maximum alactate power (MAP) of highly qualified field hockey players conducted over 14 years allows us to speak about the dynamics of an increase in the level of speed-strength fitness of the muscles of the lower extremities in the process of ontogenesis in all the studied athletes, which is confirmed by the results of regression (growth of R^2 from 0, 51 to 0.80) and correlation ($p<.01$) analyzes;
2. With age (on the example of field hockey), an athlete increases the indicators of speed-strength fitness of the muscles of the lower extremities, to a greater extent strength. Such a trend does not quite fit into the traditional theory of sports training of the dynamics of the development of physical qualities.
3. The initial age of the studied athletes (15-30 years), and the individual relative values of MAP of hockey players of various roles during the first testing did not affect the subsequent dynamics of the results of the increase in speed-strength abilities.

Adequate construction of the training process of athletes and regular monitoring of the functional state under the age of 40 contributes to an increase in the indicator of MAP. This contributed to the timely introduction of individual and group adjustments to the training process, which ultimately allowed the studied hockey players to show high sports results. The process of managing the training of hockey players in the proposed context over several Olympic cycles can be considered as a model of control.

REFERENCES

Antonov, A. (2006). *Effectiveness of the variable-game methodology of teaching 10-12 year old children systematically engaged in hockey*, Dissertation, NSA, Sofia 2006, 176 p

Antonov A., 2019, Analysis and Detection of the Degrees and Direction of Correlations between Key Indicators of Physical Fitness of 10-12-year-old Hockey Players, BIOAUTOMATION, 2019, 23(3), pp 303-314, ISSN: 1314-2321 (on-line) 1314-1902 (print)

Berdnikov, A., Mokhov, A., Zakharova, A. (2017). Research of high-speed-strength abilities of highly qualified football players. *Scientific notes of the University*. P.F. Lesgaft, St. Petersburg. – 2017,Vol. 12, (154), pp 27-33.

Chikov, A., Medvedev, D., Chikov, S. (2017). Functioning of the system of energy supply of an athlete's body during loads predominantly of aerobic and anaerobic orientation. Actual problems of biochemistry and bioenergy of sports in the XX1 century. Materials of the All-Russian Scientific Correspondence Conference April 10-12.-2018.-M.:RGUFKSMiT, pp 130-138.

Delisle-Houde, P. (2018). Relationship Between Physiologic Tests, Body Composition Changes, and On-Ice Playing Time in Canadian Collegiate Hockey Players / P. Delisle-Houde // *The Journal of Strength & Conditioning Research,* 2018, Vol. 32, №. 5, pp. 1297-1302.

Dimitrieska, T., Antonov, A. (2013). Several indicators for the development of field hockey in Bulgaria for the

period of twenty years, 17 th Symposium for Sport and Physical Education of Youth, Federation of Sports Pedagogues of the Republic of Macedonia, Ohrid, 2013, *Activities in Physical Education and Sport* 2014, Vol. 3, No. 1, pp. 125 – 128, ISSN 1857-7687

Zaborova, V., Seluyanov,V., Gavrilov, V., Rybakov, V., Markin, M. (2011). Modern methods of assessing the physical fitness of pentathletes athletes. *Sports medicine: Science and practice*, 2011, Vol.2, pp 25-28.

Zakharova, A., Berdnikov, A. (2016). Control of speed-power abilities of football players at the stage of initial specialization. *Human. Sport. Medicine*, 2016, T 16, Vol. 4, pp 64 – 74

Farfel, V. (1975). Movement control in sport, *Physical Education and Sport*, M 1975, pp 202

Green, M., Pivarnik, J., Carrier, D., Womack, C. (2006). Relationship between physiological profiles and on-ice performance of a National Collegiate Athletic Association Division I hockey team. *Journal Strength Cond Res*, pp 43–46

Guzhalovsky, A. (1986). Fundamentals of Theory and Methodology of Physical Culture, *Physical Education and Sport,* M 1986, pp 352

Golovachev, A., Kolymkhatov, V., Shirokova, S., Novikov, N. (2020). The relationship of the indicators of maximum alactate performance with the sports result of highly qualified female racers in sprint races at the stages of the Olympic cycle. Theory and practice of physical culture, 2020, Vol.8, pp. 22-25

Mehdieva, K., Zakharova, A., Owners, M., Timokhina, V. (2021). Comparative analysis of wingate testing results among high-class athletes. *Theory and practice of physical culture*, e. 2021, Vol.1, pp 29-31.

Seluyanov, V., Sarsania, K., Zaborova, V. (2012). Football: problems of physical and technical training. *Intellektik* 2012, pp 157.

Yakimovich, V. (2006). Culture in the world of sport, *The Soviet sport*, M, pp 126

NEWSru.com (2017). Hokkeistki sbornoy Velikobritanii vpervые stali olimpiyskimi chempionkami Retrieved, September 20, 2022 https://www.newsru.com/sport/20aug2016/hokbrit.html

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ANALYSIS OF THE COMPETITIVE EFFICIENCY OF THE TEAM OF CHERNOMORETS (BURGAS)

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ABSTRACT
The implementation of high-efficiency control over the game realization of the basketball players and teams makes it possible to reveal the specific features and assessment of their competitive effectiveness, which is a necessary condition for optimizing the future sports-racing process. The purpose of this study is to reveal the specifics and assess the competitive effectiveness of the team of "Chernomorets" (Burgas) during the playoff phase of the National Basketball League (NBL) during the sports-competitive 2020/2021. The subject of research is the game actions of the basketball players from the team in the extreme conditions of the competition. The test site is the signs of team competitive efficiency, found quantitative expression in the so-called "game indicators" witch integrate all sides of sports preparation. A contingent of survey is the basketball players included in the 8 teams that are participants in the said playoffs. For realization of the purpose and tasks of the study the following test methods have been used: theoretical study of specialized literary sources and monitoring and registration of game activity with the help of 16 game indicators, using a specialized computer methodology of FIBA. The source data are subjected to mathematical and statistical processing by: alternative analyses, variational analyses and sigma evaluation method. The average level and variability of all game indicators in the observed team has been revealed. On the basis of the average level for the entire population (NBL), an assessment of the results of "Chernomorets" was carried out, which outlines as the strongest strengths in its game realization the next actions: high activity in shooting for 2 points, accuracy of the shooting from the penalty line and successful rebounds in defense. In order to increase its overall game efficiency, in the future the team should focus primarily on: increasing shooting activity from the 3-points zone, improving the accuracy of shooting in the basket from all distances and increasing the activity of the game in defense.

Keywords*: basketball, elite, game realization, evaluation*

INTRODUCTION

The preparation of a basketball team is a process that requires a lot of effort from both the competitors and the coaching management. However, it is known that not always good preparation finds adequate realization in the competition. This is because competitive efficiency in elite sports is determined by a large number of factors, permanently and temporarily acting, which in their totality predetermines high sports results (Tzarov, 2012; Zhelyazkov & Dasheva, 2017). It is undisputed that one of the main factors of game efficiency is the ability of competitors to materialize their motor potential in rational technical and tactical actions (Tzarov, 2001; Jovanović et al., 2005), which is reflected in the effectiveness of the numerous games actions of the competitors, realized in the extreme conditions of the competition (Asparuhov, 2020). According to a number of authors (Zhelyazkov, 1968; Karabiberov & Bonov, 2000; Tzankov, 2005), the athleticism of basketball players is precisely the base without which the manifestation of their masterful skills would be impossible. Studies, however, show that at the end of the competition period there is a tendency to deteriorate physical preparation indicators, leading to a negative dynamics of the activity and effectiveness of the team games indicators (Kostikova & Elevich, 2004).

The implementation of highly effective control over the game realization of individual basketball players and teams allows the specific features to be discovered and evaluation of their game efficiency to be done. This allows the training and competitive processes to be optimized, based on objective information about the effect of the implemented on the athletes training impacts (Zhelyazkov, 1978; Jovanović et al., 2005; Borukova & Vasileva, 2009; Tzarov, 2012; Tzarova, 2013; 2018; Asparuhov, 2020).

The *purpose* of this study is to discover the peculiarities and evaluate the competitive efficiency of the team of Chernomorets (Burgas) during the playoff phase of the National Basketball League (NBL) during the sports-racing 2020/2021.

METHODS

The study was conducted in the period April - June

2021. The *subject* of research is the game actions of the basketball players from the team of "Chernomorets" (Burgas) in the extreme conditions of the competition. The *object* of research is the signs of the team's competitive efficiency, which is quantitative in the so-called game indicators. The *participants* of the study are a total of 96 basketball players included in the 8 teams involved in the playoff phase of the National Basketball League (NBL) during the sports-racing 2020/2021.

For the needs of the study the next *methods* were used: *theoretical study of literary sources and monitoring and registration of play activities* (with the help of 16 play indicators) using a specialized computer program of FIBA. The output data is subjected to *mathematical-statistical* processing by: *alternative analysis, variational analysis and sigma evaluation method.*

RESULTS

The results of the variational analysis (Table 1) show that during the study period the team marked per game an average of 84.50 points.

Table 1. *Average level and variability of the indicators of competitive effectiveness*

№	Indicators \ Parameters	X	S	V	min	max
1.	Points	84.50	8.09	9.57	68	95
2.	Ge4neral shooting - attempts	73.25	8.91	12.16	63	87
3.	Ge4neral shooting - %	43.75	6.69	15.30	38	57
4.	Shooting for 2 points - attempts	48.63	8.40	17.27	35	59
5.	Shooting for 2 points - %	50.50	7.48	14.82	42	64
6.	Shooting for 3 points - attempts	24.63	5.15	20.93	15	32
7.	Shooting for 3 points - %	29.50	8.85	29.99	14	46
8.	Free throws - attempts	18.00	7.45	41.36	6	29
9.	Free throws - %	76.38	8.72	11.41	59	85
10.	Offensive rebounds - %	24.38	7.80	32.01	15.15	41.03
11.	Defensive rebounds - %	74.88	6.34	8.46	64.71	81.58
12.	Assists	17.00	2.07	12.18	15	21
13.	Steals	8.25	2.66	32.23	4	12
14.	Turnovers	14.50	4.57	31.50	22	7
15.	Personal Fouls	18.75	1.58	8.43	21	17
16.	Coefficient of efficiency	89.00	12.95	14.55	63	103

The additional calculations show that the highest number of points per game (49.06 points) the team achieved from near and average distances (from the 2-point area). This is completely real, given that not only the points achieved from the 2-point zone in the time of the game are included here, but also those that were realized after successfully conducted fast breaks and counterattacks. A much smaller share of the points (25.73%) is achieved from long distance (the 3-points area) - they are one quarter (21.74 points) of all points realized. However, it is noteworthy that the team added in one game an average of only 13.70 points of successfully executed free throws, representing only 16.21% of all points scored.

The analysis of Figure 1 shows that the basketball players from the team were twice as active in firing from near and medium distances as from long distances - 48.63 against 24.62 attempts. Here is an impression in our opinion the low number of free throws accepted (only 18).

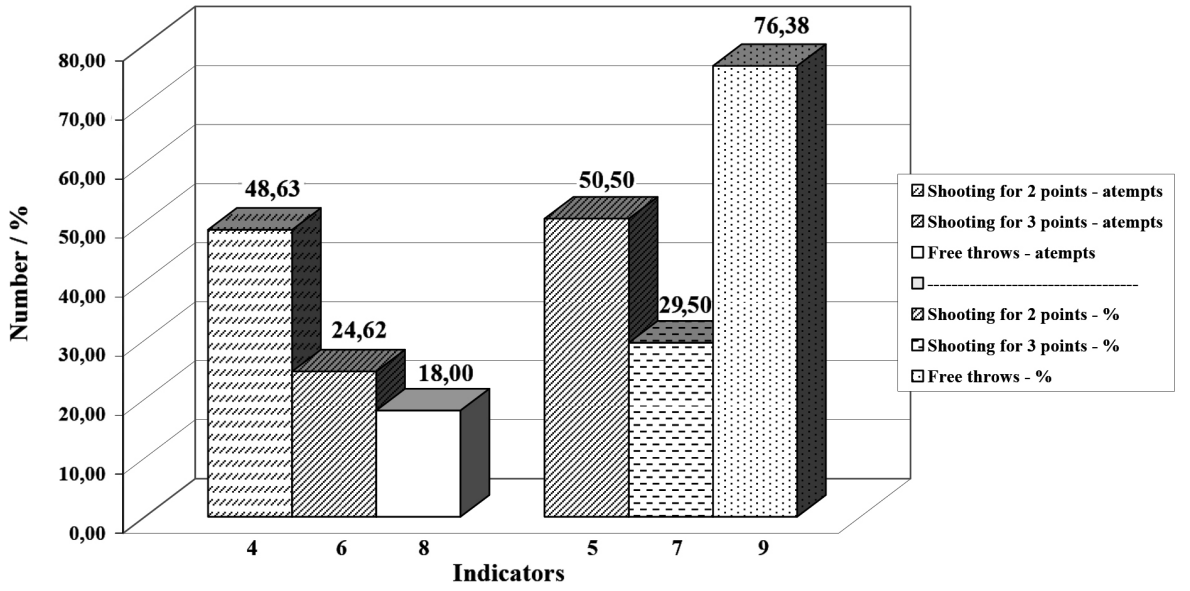

Figure 1. *Quantitative and qualitative indicators of the shooting in the basket*

The effectiveness of shooting in the basket is an extremely important indicator of success in basketball. The figure shows that the team realized 50.50% of the shooting from the area for 2 points and 29.50% from this for 3 points, thanks to which the overall efficiency during the study period is an average of 43.75%. Naturally, the effectiveness of the shooting from the free throw line is much higher (76.38%).

As can be seen from Table 1, the average efficiency of the rebounds under own basket in defense is almost 75%, but in the offence, only 24.38% of the unsuccessful shooting of the studied basketball players fall into their hands again.

In the group of the so-called "additional" or "constituting" indicators (from 12 to 15th) are included 4 indicators that are not directly related to the shooting in the basket but are extremely important for the overall racing efficiency of every team. The analysis of the table shows that during the study period, an average of one game, the competitors from the observed team have passed 17 assists. They have also taken away more than 8 balls from the opponent and at the same time have made around 15 mistakes and almost 19 personal fouls.

In order to evaluate the overall racing efficiency of the teams, in recent years, official FIBA statistics also included the so-called Efficiency ratio, which is calculated on the basis of results on all game indicators. Our research shows that the average efficiency of the team of "Chernomorets" during the playoffs is 89 units. The highest competitive efficiency has been achieved in the matches with the teams of "Yambol" and "Academic" (Plovdiv) (respectively 103 and 102 units). Extremely low is the effectiveness of the team in the last meeting with the team of "Levski" (only 63 units).

Important information about the study gives the analysis of the degree of variation of the indicators of the game efficiency. The analysis shows that in 3 of the indicators the values of the variation coefficient V are lower than 10% and therefore, the play of the research team was stable in terms of the number of personal fouls performed (V_{15} = 8.43%), the efficiency of the offense rebounds (V_{11} = 8.46%) and the number of points noted (V_{1} = 8.46%). At the same time, with 5 of the indicators, the values of V are higher than 30%, which is evidence of the instability of the game with respect to the signs for which the relevant indicators carry information.

To solve the purpose and tasks of the study, using the so-called sigma evaluation method, based on the average level for the entire Bulgarian National Basketball League, the results of the team of "Chernomorets" has been evaluated (Figure 2).

As can be seen from Figure 2, the highest degree of realization in game conditions is observed with regard to the activity of the competitors in the shooting of the 2-point area, which has a positive

effect on the overall activity of the shooting in the basket (indicators 2 and 4 - 50 points each). High estimates are also observed in terms of accuracy in the execution of the free throws (42.05 points) and the effectiveness of the rebounds under one's own basket in defense (30.70 points).

At the same time, however, the estimates of 7 of the observed indicators are lower than 20 points, which is a sign of a low level of realization of the relevant game signs. These are indicators characterizing the activity of the shooting from the area for 3 points (indicator 6 – 15.91 points), the effectiveness of the shooting in the time of the game (indicators 3, 5 and 7 respectively 16.60, 14.61 and 1.00 points), the activity of the game in defense (indicator 13 - 14.20 points), the ability to see the game and to submit assist passes (indicator 12 - 18.04 points) and the level of the demonstrated technical and tactical mastery (19.45 points), which is expressed in the technical errors made by the competitors.

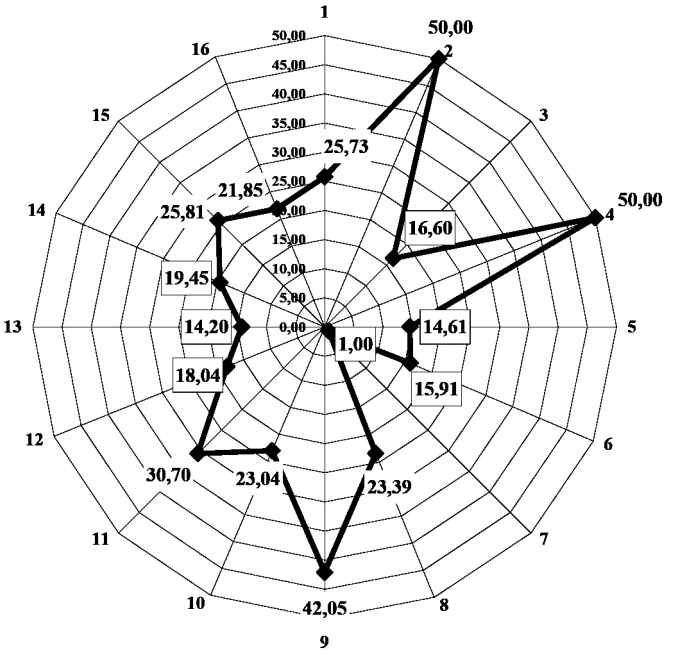

Figure 2. *Optimization model of the game efficiency*

DISCUSSION

The fact that during the study period the team marked an average of one match of 84.50 points, in our opinion, is an indicator of good realization capabilities of a team of a similar rank, but this is not enough for the prize rankings in the NBL - the best team in the League (the one of the "Rilski Sportist") reached an average of 92 points per match.

According to K. Tzarov (2012), the contribution of the area of 3-points to the overall efficiency of basketball players is a very important component of competitive realization. However, as can be seen from the analysis, the team of "Chernomorets" is not able to fully take advantage of the opportunity that gives the shooting for 3 points for a faster increase in the result. Proof of this is the low estimates of indicators 6 and 7.

The problem with the small number of successful free throws is also serious - only 13.7 on average at one match, which represents only 16.21% of all points scored. According to literary data (Preobrajenski & Kudinkina, 1968; Tzarov, 2003, 2012), the elite teams add to their overall result an average of 25 and 30 points.

The ability to successfully participate in the fight for the ball under the two baskets is extremely important for any team. As can be seen from the analysis of the results, the average performance of the research team in defense is a good certificate for the skills of basketball players to master the bounces after unsuccessful shooting balls and it is no accident that the assessment of this skill is 30.70 points. The efficiency of the basketball players in the fight under the opponent's basket in offense, however, is

not so good - here the estimate is only 23.04 points.

The number of assists is evidence of the level of development of the ability to see the game and to submit accurately (by space, time and effort) passes. The ability to interrupt the opponent's attacks by steals of the ball is a sign of the high aggressiveness of the game in defense. The amount of technical errors depends on the ability of basketball players to handle the ball. Unfortunately, the results show that here the team of "Chernomorets" has serious problems - the estimates of indicators of 12 to 14 are quite low and move between 14.20 points and 19.45 points.

The analysis of the results shows that the game of the team was stable in terms of the amount of personal fouls, the effectiveness of the defensive rebounds and the number of points noted. At the same time, in 5 of the indicators, there is an instability, which is a sign of the instability of the game of the team with respect to the signs for which these indicators carry information (Tzarova, 2013).

CONCLUSION

The high variability of some of the tested signs of competitive realization gives reason to in the future to invest additional training efforts in individual work with some of the players to improve their skills for higher activity in the attack in one against one situations, for a more high aggressiveness in the play in defense, to increase the effectiveness of the offensive rebounds, to increase individual technical and tactical mastery in handling the ball and to increase the efficiency of the shooting for 3 points.

The performed on the basis of the average level for the entire general aggregation (NBL) assessment of the results of "Chernomorets", delineates as the strongest sides in its playing realization: the high activity in the shooting for 2 points, the accuracy in the execution of the free throws and the successful fighting for the ball in defense. In order to increase its overall game efficiency, in the future, the team must focus mainly on: *increase the activity of shooting from the area for 3 points, improving the accuracy of shooting in the basket from all distances and increasing the activity of the game in defense.*

When optimizing the future training process, the coach must fully implement his knowledge and skills to make an optimal strategic solution, which means thus distributing the total amount of tolerable workload to guarantee with an acceptable high degree of maximum effect on the sports achievement of his team (Brogli, 2012).

REFERENCES

Asparuhov, Ya. (2020). Analiz na sastezatelnata efektivnost na basketbolen klub "Beroe" kadeti`16 ot Republikanskoto parvenstvo prez 2019 g. *Godishnik na Natsionalna sportna akademiya*, Tom 2, Es print OOD, Sofiya, str. 195-205. // Аспарухов, Я. (2020). Анализ на състезателната ефективност на баскетболен клуб "Берое" кадети`16 от Републиканското първенство през 2019 г. *Годишник на Национална спортна академия*, Том 2, Ес принт ООД, София, стр. 195-205.

Borukova, M. & Vasileva, A. (2009). Izsledvane na individualnata sastezatelna efektivnost na basketbolistkite ot otbora na Stara Zagora. *Sport i nauka*, Izv. broy 4, Sofiya, str. 43-48. // Борукова, М. & Василева, А. (2009). Изследване на индивидуалната състезателна ефективност на баскетболистките от отбора на Стара Загора. *Спорт и наука*, Изв. брой 4, София, стр. 43-48.

Borukova, M. (2018). *Kontrol na sportnata podgotvenost pri 13-14-godishni basketbolistki.* BOLID INS, Sofiya. ISBN 978-954-394-242-8 // Борукова, М. (2018). *Контрол на спортната подготвеност при 13-14-годишни баскетболистки*. БОЛИД ИНС, София. ISBN 978-954-394-242-8

Borukova,M. (2020). Decreasing the Effectiveness for Shooting the Basket: A Basic Problem for the U16, U18 and U20 European Women`s Basketball. *Sport Mont*,18 (3), DOI:10.26773/smj.201014.

Brogli, Ya. (2012). *Vavedenie v teoriyata i praktikata na kontrola varhu faktorite na sportnoto postizhenie.* BPS OOD, Sofiya. // Брогли, Я. (2012). *Въведение в теорията и практиката на контрола върху факторите на спортното постижение*. БПС ООД, София.

Jovanović, I., Jovanović, D. & Petrov, L. (2005). Prerequisites for team success at the European basketball championships in Sweden 2003, resulting from the official statistics indexes of striking the ring. *Sport & Science*, extraordinary number 4, Sofia, pp. 102-108.

Karabiberov, Yu. & Bonov, P. (2000). *Atleticheska podgotovka v basketbola*. NSA Pres, Sofiya. // Карабиберов, Ю. & Бонов, П. (2000). *Атлетическа подготовка в баскетбола*. НСА Прес, София.

Kostikova, L. & Elevich, S. (2004). Spetsialynaya podgotovlennosty basketbolistov v sorevnovatelynom periode. Sportivnыe igrы: nastoyashtee i budush-

tee. SPb GAFK im. P. F. Lesgafta, Sankt-Peterburg, str. 89-92. // Костикова, Л. & Елевич, С. (2004). Специальная подготовленность баскетболистов в соревновательном периоде. Спортивные игры: настоящее и будущее. *СПб ГАФК им.* П. Ф. Лесгафта, Санкт-Петербург, стр. 89-92.

Preobrazhenskiy, I. & Kudinkina, E. (1968). Shtrafnoy brosok v tsentre vnimania. // Sport za rubezhom, Moskva. // Преображенский, И. & Кудинкина, Е. (1968). *Штрафной бросок в центре внимания*. // Спорт за рубежом, Москва.

Tsankov, Ts. (2005). *Skorostno-silovata podgotovka na podrastvashti basketbolistki*. Monografiya, NSA – Pres, Sofiya. // Цанков, Ц. (2005). *Скоростно-силовата подготовка на подрастващи баскетболистки*. Монография, НСА – Прес, София.

Tsarov, K. (2001). Faktori na sastezatelnata efektivnost na elitni otbori po basketbol. Dis. trud, NSA, Sofiya. // Църов, К. (2001). Фактори на състезателната ефективност на елитни отбори по баскетбол. Дис. труд, НСА, София.

Tsarov, K. (2002). Sravnitelen analiz na otbornata igrova efektivnost na svetovniya mazhki basketbolen elit v perioda 1987-2000 g. // *Sport i nauka*, Broy 1, Sofiya, str. 35. // Църов, К. (2002). Сравнителен анализ на отборната игрова ефективност на световния мъжки баскетболен елит в периода 1987-2000 г. // *Спорт и наука*, Брой 1, София, стр. 35 .

Tsarov, K. (2012). *Sastezatelnata efektivnost v basketbola*. Bolid ins, Sofiya. // Църов, К. (2012). *Състезателната ефективност в баскетбола*. Болид инс, София.

Tsarova, R. (2013). *Problemi na kontrola v basketbola*. Monografiya, Bolid ins, Sofiya. // Църова, Р. (2013). *Проблеми на контрола в баскетбола*. Монография, Болид инс, София.

Zhelyazkov, Ts. & Dasheva, D. (2017). *Osnovi na sportnata trenirovka*. BOLID-INS, Sofiya. // Желязков, Ц. & Дашева, Д. (2017). *Основи на спортната тренировка*. БОЛИД-ИНС, София.

Zhelyazkov, Ts. (1968). *Basketbol – razvitie na igrata i problemat za atletizma*. Meditsina i fizkultura, Sofiya. // Желязков, Ц. (1968). *Баскетбол – развитие на играта и проблемът за атлетизма*. Медицина и физкултура, София.

Zhelyazkov, Ts. (1978). Metodologichni osnovi na upravlenieto i optimiziraneto na sportnata podgotovka pri visokokvalifitsirani sportisti. Dis. trud - DPN, VIF, Sofiya. // Желязков, Ц. (1978). Методологични основи на управлението и оптимизирането на спортната подготовка при висококвалифицирани спортисти. Дис. труд - ДПН, ВИФ, София.

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RESEARCH ON THE RISKS IN CYBERSPACE DURING SPORTING EVENTS

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ABSTRACT
Introduction: Every major sporting event, is a huge challenge in terms of information security. The main reason for this is the huge spectator interest, the active media coverage of the event, which „attracts" and an unwanted contingent of people seeking to acquire „assets" in a dubious way. Developing more innovative and effective malware protection mechanisms is considered an urgent requirement in the cybersecurity community.
Methodology: In the research process we have applied: information research, document analysis, historical analysis, conclusions based on personal experience, monitoring, synthesis, and theoretical analysis. A theoretical overview of the basics of security and requirements for information technology supporting sports events.
Results: The purpose of the report is to analyze the cybersecurity of information systems supporting mass sporting events and to create systems of measures to prevent cyberterrorist attacks during sporting events.
Discussion: In support of the allegations made so far concerning the information security of any mass sporting event, we will cite various examples. As with any Internet-related system, hackers can try to manipulate the content or interfere with sports websites and e-mail systems.
Conclusion: One way to increase cybersecurity during a „mass sporting event" is to hire specialized companies to control cyberspace activities. Although cybercriminals are becoming more advanced, with the right approach and a little common sense, we can learn to stay one step ahead. The sport will continue to use more and more technology.

Keywords*: cybersecurity, cyber threat, cyber-attack, sporting events, vulnerability.*

INTRODUCTION

Every major sporting event, be it national or international, related to, scientific forums, exhibitions, fairs, Olympic Games, presents a huge challenge in terms of information security. The main reason for this is the huge viewership interest, and the active media coverage of the event, which „attracts" an unwanted contingent of persons seeking to acquire „assets" in a legally dubious manner. These problems related to ensuring adequate cyber protection for the persons involved in the event, be it physical or digital, are within the competence of the relevant specialized services.

Information security is a practice to protect systems, networks, and programs from digital attacks. These attacks are usually aimed at accessing, modifying, or destroying sensitive information; extortion for money from consumers, or disrupting of normal business processes. Implementing effective cybersecurity measures today is particularly challenging because there are more devices than people, and attackers are becoming more innovative. The exponential growth of internet connections has led to a significant increase in cyber-attack incidents, often with catastrophic and severe consequences. Malware is the main choice of weapon to commit malicious intent in cyberspace, either by exploiting existing vulnerabilities or by using unique features of emerging technologies. Developing more innovative and effective anti-malware mechanisms is considered an urgent requirement in the cybersecurity community.

The term „Mass Event" or „Major Event" has only appeared in the academic field since 1987, when the Association Internationale d'Experts Scientifiques du Tourisme of Calgary considered the impact of „mega" events on the development of regional and national tourism. Since then, this concept has often been associated with entertainment, tourism, and urbanism. For example, according to Swiss Professor Martin Mueller, „Major Events" are outpatient cases of fixed duration, which:
(a) attract a large number of visitors;
(b) have a large intermediary scope;
(c) come at high costs;
(d) have a major impact on the environment and population.

For others, „Big Event" represents – significant national or global competitions that produce a wide level of participation and media coverage and often require large public investment in infrastruc-

ture related both to the location of the event – for example, stadiums, halls, and general infrastructures, such as roads, housing or mass transit systems. Over the past decade, information and communication technologies have become ubiquitous and have evolved to such an extent that they have now become a stimulant of all spectacular events. This applies to: international fairs, major concerts, sporting events, economic or political meetings and the like, which increasingly rely on their overall structure (e.g.: timers, security cameras, magnetic or RFID badges, microphones, translators, mobile applications, etc.). These are examples of direct information and communication technologies that are directly responsible for the proper and smooth functioning of any large-scale event. Of immediate importance for each „major event" is also the dependence on the broad „indirect" infrastructure and public providers of information and communication technologies, hotels, transport, etc., which are directly responsible for the proper and smooth functioning of the event concerned. All these components have „opened the door" to new cyber risks and threats.

The aim of the study

The goal we set for ourselves in this material was to examine and point out the cyber security risks during major sporting mass events. In order to meet the goal thus set, we will serve with historical examples that relate to cyberterrorism acts affecting mass sporting events of different ranks.

METHODS

In the research process, we have applied: information research, document analysis, and historical analysis, conclusions based on personal experience, S.W.O.T analysis, monitoring, synthesis, and theoretical analysis. A theoretical overview of the basics of security and requirements for information technology supporting sports events.

RESULTS

The purpose of the report is to analyze the cybersecurity of information systems supporting mass sporting events and to create systems of measures to prevent cyberterrorist attacks during a sporting event

Digital technologies involved in organizing and hosting every single mass sporting event are increasingly facing threats. While most hacks (unauthorized intrusion into a computer or network) today focus on the information systems of sports stadiums and tickets, for example, future risks may include hacking attacks that violate both the integrity of the results of sporting events and the main operations of stadiums. Studies identify the following key areas of risk for future sporting events:
Unauthorized intrusions into the stadium system;
Technologies affecting the points system;

- Play photos and videos;
- Manipulation of athletes;
- Manipulation of entry into the sports facility;
- Transport manipulations;
- Facilitating terrorism;
- Panic-inducing manipulations.

Problems affecting the integrity of sports are of particular concern as they can be extremely difficult to identify. Problems affecting the integrity of sports are of particular concern as they can be extremely difficult to identify.

DISCUSSION

Given the scope of a "major sporting event", information security is a defining aspect for its organization. In fact, widespread media coverage, high investment, and the fact that host countries use these events as geopolitical and software platforms in power make them tempting targets for cybercriminals and hackers. Accordingly, organizers and host countries must lose too much if they fail to take security seriously (i.e. reputational damage, loss of future foreign investment, loss of money already invested, etc.). Organizing major sporting events requires close cooperation between the private, and public sectors and society. The sports industry is vulnerable to cyberattacks. In fact, the number of online threats in the sports industry has evolved with the rapid development of technology. For reference, below we have presented a short extract of various online scams (related to sporting events):

Some of the most notable examples of sports-related cybercrimes in recent history include the Olympics and the World Cup, perhaps the two most significant sporting events of our time.

In support of the statements made so far concerning the information security of each mass sporting event, we will provide different examples. As with any other internet-connected system, hackers can try to manipulate the content or interfere with the

functioning of sports websites and email systems. For example, the 2008 Beijing Olympics. It was a phishing site that stole data about their credit cards and other personal information.

Hackers from the Anonymous group once broke into the Formula One website, protesting against the staging of the Bahrain Grand Prix. (Liebowitz, 2012)

Testing of computer emergency response teams and their ability to work together with other national and international cybersecurity actors (crisis simulations, risk management exercises, war games, etc.)

London Olympics 2012 - a spam campaign deceived several users via email. The victims were informed that they had won a competition, the "Lottery at the London 2012 Olympic Games." And to claim the grand prize at this competition, victims were asked to share their personal data (including online banking information). (Beware of 2012 London Olympics Spam Email Cyberattacks, 2012)

In 2013, Chris Correa, director of sports intelligence for the St. Louis Cardinals, managed to hack into the Houston Astros' database. He had access through a former Cardinals official who joined the Astros and again used the same password. From 2013 to 2015, the Cardinals had access to all of the Astros' scouting, games, strategies, and scouting prospects. Correa used the Astros' database 32 times. When he was captured, he was also sentenced to 46 months in prison on 12 counts of corporate espionage. He had to recoup a $279,000 loss to the Astros and was banished from baseball for good. The Cardinals also had to pay $2 million. 1 for the Astros, and the two highest marks of 2017 were awarded to the Astros. (Press, 2016)

Fifa World Cup 2014 Brazil: Starting with injecting a Trojan horse to advertising and phishing attacks, cybercriminals wasted no time in profiting from a long-awaited football tournament, i.e. ordinary users and fans were tricked into revealing sensitive details, including personal and financial information through phishing websites, spam emails, search engines and fake apps. (Kaspersky, 2014)

In 2015, hackers accessed performance data from leading cyclist Chris Froome in an attempt to discredit him. The hackers also compromised the World Anti-Doping Agency and released confidential data about which Rio Olympians were denied to take banned stimulants that improved their performance. The hackers claim that the evidence shows that American athletes in particular gain an unfair advantage. (Lindsey, 2015)

One recurring attacking method is the use of Distributed Denial of Service (DDoS) attacks that try to make online services unavailable by overloading traffic servers. For example, brazil's World Cup faced successful DDoS attacks that ceased the operation of sports websites, such as those of the Ministry of Sport. The Rio Olympics also suffered a similar DDoS attack. (Israel, 2014)

Hackers have compromised the World Anti-Doping Agency and released confidential data on which Rio Olympians have been denied banned stimulants that improve their performance. The hackers claim that the evidence shows that American athletes in particular gain an unfair advantage.

In 2018, the International Association of Athletics Federations announced that it had been the victim of a cyberattack by the Russian hacking group Fancy Bear. The IAAF said hackers had threatened to expose athletes who used banned stimulants during the Olympics. (Homewood, 2017)

During the 2018 Fifa World Cup, some examples of successful social engineering techniques were found that tricked users into downloading malware. Despite their simplicity, these attacks often prove successful thanks to human curiosity and pureness. (Social engineering: how the human factor puts your company at risk, 2018)

According to Alice Crelier, organizing „major events „requires close cooperation between the private and public sectors of the host country. This represents a good opportunity for training, information sharing, infrastructure testing, and better risk management. „Major events" can also be seen as opportunities for concrete improvement and testing of crisis response mechanisms in the country, corresponding to:

Based on the processed results, we conducted S.W.O.T - an analysis of the opportunities and prospects for the risks in cyberspace during sporting events (Table 1).

Table 1. *S.W.O.T analysis*

Strengths	**Weaknesses**
Computer software and hardware systems that are protected with firewalls, anti-malware, and anti-virus programs are a strength. Another strength are employees who respect the need for using the correct passwords and use computer systems and apps only for work-related projects. If all the windows and doors lock and are they locked after business hours, this is a strength. If patents, copyrights, trademarks, and trade names are all protected under law, this is a strength. High-speed Internet and connectivity Bulgarian information communication technologies companies and professionals are engaged for service providers in the field of cyber forensics Developed information society	Lack of funding for security purposes is a weakness that can be difficult to overcome. Not enforcing intellectual property protection is a weakness that can result in a weakened brand and lost sales. A lax attitude about updating software protection is another weakness. Correcting some weaknesses, such as installing new security systems, will cost money. But other efforts, such as reminding employees of the importance of locking the workplace after hours, are free. A small effort such as changing computer passwords to random strings of numbers and letters could prevent unauthorized computer access. Lack of clear policies and common rules for providing cyber security Underdeveloped and adequate legal framework with regard to cyber security Lack of an early detection system in place cyber-attack warning Use software and hardware solutions without security elements or commitments
Opportunities	**Threats**
Technology development – increasing efficiency at a decreasing price Relatively easy to overcome technological backwardness Virtually unlimited access to knowledge Systematic development of information culture in schools New security systems and products come onto the marketplace on a regular basis. Data is secure and backed up by an outside company. The money saved could be put toward additional security measures	The EU‘s most economically lagging country Global cybercrime growth in increasing global uncertainty Constant increase in the quantity, intensity and complexity of cyber attacks (including unnoticed) Hybrid nature of threats – interconnection, domino effect Increase digital dependence - penetration in all spheres of life (IoT - all devices are connected on the Internet) Impossible maintenance of „partial security“ Threat to the environment for the development of outsourcing services to Bulgaria Expiration of intellectual potential (especially in the field of ICT) Use of unlicensed, pirated software (especially from citizens and SMEs) Expansion of cloud services where security is not always guaranteed High level of use of social networks (channel for possible penetration, espionage, terrorism) Development of organised cybercrime Huge growth in the supply of services and online entertainment Transfer of the illegal (gray) market in cyberspace (trafficking in human beings, organs, drugs, weapons, etc.) the Internet is an uncontrollable channel of misinformation (easy creation of panic, psychosis, financial instability, etc.) Mother Nature is another security threat when it comes to storms, fires, earthquakes and flooding. Back up important information and documents to help prepare for these disasters. You should also be aware of, and prepare for, new computer viruses, hacking and phishing attacks. Make sure you keep your computer systems protected with the latest and best anti-virus software. Threats also come from dissatisfied customers, disgruntled employees or unethical competitors.

Conclusions from S.W.O.T analysis:
On the basis of the research, we have formulated the following conclusions:
One way to increase cybersecurity during a "massive sporting event" is to hire specialized companies to control activities in cyberspace. Although cyber criminals are becoming more advanced, with the right approach and a little common sense, we can learn to stay one step ahead. In order to improve cyber security standards and raise participants' awareness, the following practices can be applied:

1. Carrying out routine security audits. For a sports organization, for example, this may mean auditing all internal databases, user systems, and devices that communicate with each other and store sensitive data.

2. Using data offline, where possible, is the easiest solution to restrict access to sensitive information on all devices connected to the Internet. While this removes the convenience of using devices, this is the best way to protect sensitive information.

Sports will continue to use more and more technology. But we must not take these technologies or privacy for granted but should strive for consistency and best practices when using the necessary cybersecurity tools. For all this, of course, it takes time and resources.

After completing this study, we can make the following recommendations:

Visibility is another key to security. With a huge number of people entering accounts from multiple devices and locations, there is an overload of information, making it difficult to understand the bigger picture of what is happening in an organization's digital ecosystem. When an organization is able to gather all the information in one system, it helps to paint a clearer picture of the current situation and analyze all potential threats.

As the threat of cyber attacks on sports organisations grows, it is vital for managers to actively prepare for such an opportunity.

It's cheaper to think about these things in advance, rather than paying an incident response team to clean up the mess after you've been hacked. Many times, once the damage has been done, there is no going back. Unfortunately, there are organisations that have been drilled and collapsed, and wish they had done this preparatory work in advance

REFERENCES

Beware of 2012 London Olympics Spam Email Cyberattacks. (2012, Apr 3). Retrieved from WebTitan: https://www.webtitan.com/blog/cyber-attacks-multiply-in-run-up-to-the-2012-london-olympics/

Homewood, B. (2017, APRIL 3). *IAAF says medical records compromised by Fancy Bear hacking group.* Retrieved from reuters.com: https://www.reuters.com/article/us-sport-doping-iaaf-idUSKBN1750ZM

Israel, E. (2014, JUNE 11). *Hackers claim attacks on World Cup-related websites.* Retrieved from https://www.reuters.com/: https://www.reuters.com/article/uk-brazil-worldcup-hackers-idUKKBN0EM1ZC20140611

Kaspersky. (2014, May 22). *World Cup 2014: Phishers and Scammers Target the Global Soccer Fiesta*. Retrieved from Kaspersky: https://www.kaspersky.com/about/press-releases/2014_world-cup-2014-phishers-and-scammers-target-the-global-soccer-fiesta

Liebowitz, M. (2012, April 20). *Anonymous Attacks Formula 1 Site to Protest Race in Bahrain*. Retrieved from News: https://www.nbcnews.com/id/wbna47119609

Lindsey, J. (2015, 2015 17). *Chris Froome's Crazy Data Hack Scandal.* Retrieved from Bicicling: https://www.bicycling.com/racing/a20027055/chris-froome-s-crazy-data-hack-scandal/

Press, A. (2016, July 18). *Christopher Correa, Former Cardinals Executive, Sentenced to Four Years for Hacking Astros' Database*. Retrieved from The New York Times: https://www.nytimes.com/2016/07/19/sports/baseball/christopher-correa-a-former-cardinals-executive-sentenced-to-four-years-for-hacking-astros-database.html

Social engineering: how the human factor puts your company at risk. (2018, April 9). Retrieved from positive technology: https://www.ptsecurity.com/ww-en/analytics/social-engineering-2018/

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A STUDY OF THE PHYSICAL LOADS OF MIDWIVES IN THEIR WORK PROCESS WITH PATIENTS

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ABSTRACT
Midwives belong to one of the largest groups of healthcare professionals working at multiple hospitals in Bulgaria. They are an essential part of the treatment and diagnostic process of recovery and healing among women with gynecological problems, pregnant women, women in and after labor, and newborns (Hadzhideleva, 2014). In their daily work, midwives face various situations requiring quick and precise responses and adequate professional behavior. This suggests the occurrence of numerous psychologically stressful situations as well as physical strain in the process of work. This survey aims to assess the volume of the physical strain of midwives while working with patients by measuring their heart rates, the number of steps, and the distance covered. The study was conducted by applying combined measurements, including indicators such as age, height, weight, heart rate, number of steps, and distance covered within a single workday of 15 midwives from three medical institutions who participated in the survey. In order to increase the precision of data measurements, HUAWEI - Watch Fit, Body Composition Fat Scale 3, and Polar products were used. The data analysis indicates that the average distance covered by a health worker in a single workday is 6.70 km and the maximum heart rate at the end of the workday reaches up to 159 bpm with an average of 106 bpm, which indicates that midwives are subjected to significant workloads that lead to excessive fatigue and stress.
According to the European Agency for Safety and Health at Work, stress is the second most significant factor that causes health problems among health workers, and almost one in every four has been affected by this factor (OSHA, 2022)
The conclusions that can be drawn are that the specifics of the midwives' work entail multiple tasks and obligations and high intensity of physical load, which leads to excessive physical and emotional fatigue. In order to keep up the quality of work of health workers, it is necessary to take measures that aim to optimize the work process and improve the working conditions at medical institutions by observing recess times.

Keywords*: midwife, physical load, work process, patient care*

INTRODUCTION

The specifics of the midwives' work involve multiple tasks and obligations that demand a significant physical strain, as the challenges that these medical specialists face include:

- Assisting the gynecology specialist when aiding patients, performing medical manipulations and healing procedures, and organizing diagnostic examinations assigned by the doctor.
- Assisting the doctors in the office when performing consultations and examinations on patients and performing the respective medical manipulations.
- Preparation of the samples taken during the examinations and sending them to the laboratory.
- Completing medical documentation assigned by the doctor following the doctor's instructions.
- Overviewing the order of patient admission and attending to patient needs concerning their physical condition and age.
- Prescribing medication and consumptives needed for the office operation and controlling the sterility of medical instruments while being used.

The midwife's profession is directly connected to the patient and requires efficient, professional relationships that motivate the patient to participate actively and cooperate in the process of midwife care. Midwives need to constantly maintain an emotional connection with the patient, achieve adequate emotional support, alleviate pain and anxiety, build confidence, and support patients in maintaining appropriate healthy behavior (Aleksandrova, 2007; Borisov et al., 2001; Velev, Nisheva, 2004). This suggests the development of numerous psychologically stressful situations and conditions at work. Almost one in every four medical workers has been affected, and surveys show that between 50 % and 60 % of all "lost" working days relate to stress. "Stress" as a term, was introduced in 1944 (Lazarus, 1966) and related to all sorts of change that lead to physical, emotional, or physiological strain. Stress affects people due to emotional impacts and extreme physical and emotional loads and leads to fatigue, which lowers the quality of work in the health sector. According to the extensive research that has been done on the topic of physical strain on health care workers - midwives, we have come across numerous scientific articles that relate more to guidelines for improving the health of pregnant women and parturients than the midwives themselves. This

makes us believe that there is a lack of developments on similar topics directly related to the problems of people working in the health care system. We believe that the relevance of the study can contribute to a deeper analysis of the state of some of the problems in the healthcare system in Bulgaria and help to improve the quality of the work process with patients in hospitals.

Aim. The aim of the study is, through applying modern technology and portable smart devices, to monitor the indicators of heart rate, the number of steps made, and the overall distance covered by midwives, as a group of medical workers, in the course of an 8-hour work day in order to assess the degree and the volume of physical load in the process of their work with patients.

METHODOLOGY

Participants

The study was conducted in 2021 and involved 15 midwives working in the IVF wards and gynecological consultative cabinets of three leading healthcare facilities in Bulgaria on a daily shift with 8 hour working day.

Study protocol

The study methodology is divided into three parts:

- Hourly measuring and recording the heart rate of midwives through a Polar H7 heart rate sensor strap for the duration of an 8-hour workday with patients.
- Measuring the number of strides made and the distance covered within a workday using a Huawei Watch Fit watch.
- Measuring the indicators of age, height, and weight using Huawei Fat Scale 3 scale.

The latest health and fitness software technologies are made simple, secure, and easy to use. The data in our study were collected and processed by the smartphone application Huawei Health, which provides highly comprehensive details of health statistics and gives easy access to records of heart rate, blood oxygen levels, blood pressure, sleep quality, step count, and more. Records every activity from wearables in over 100 different sports, from beginner to advanced levels. Displays data for each workout, tracking every step to ensure end goals are met. All data is displayed in clear, dynamic graphs, which encourages monitoring the human body's essential life processes. The wearables we use in this study are part of the Huawei Health ecosystem and work in complete synchrony in collecting, processing, and initializing the final data.

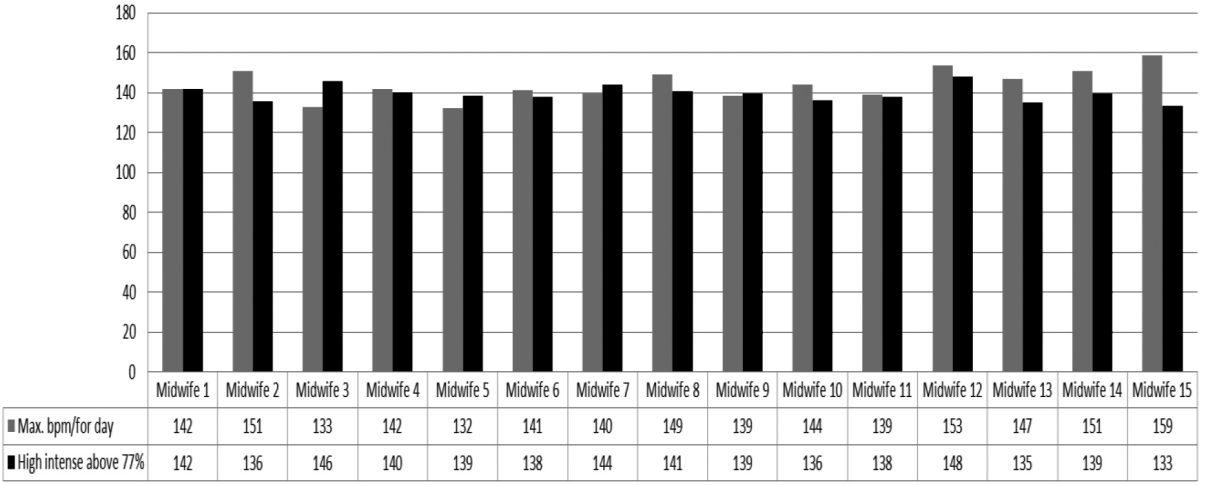
RESULTS AND ANALYSIS

The analysis of the present survey shows that the maximum heart rate among the health workers studied varies from 151 to 159 bpm (Table 1), and the average heart rate is 106 bpm.

Table 1. *Distribution of heart rate by hours and max heart rate per person and age of the studied midwives*

	Age	Heart rate at 9h/bpm	Heart rate at 10h/bpm	Heart rate at 11h/bpm	Heart rate at 12h/bpm	Heart rate at 13h/bpm	Heart rate at 14h/bpm	Heart rate at 15h/bpm	Heart rate at 16h/bpm	Heart rate at 17h/bpm	Max bpm/ for day	Max hear rate per person/age
Midwife 1	36	89	97	113	99	121	126	129	133	142	142	184
Midwife 2	44	79	84	99	112	119	128	134	138	151	151	176
Midwife 3	31	69	73	69	84	71	74	111	119	133	133	189
Midwife 4	38	78	84	86	89	95	104	115	129	142	142	182
Midwife 5	40	87	81	87	91	93	91	99	107	132	132	180
Midwife 6	41	93	87	93	97	100	97	106	114	141	141	179
Midwife 7	33	72	77	72	88	75	78	117	125	140	140	187
Midwife 8	37	82	88	90	93	100	109	121	135	149	149	183
Midwife 9	39	91	85	91	96	98	96	104	112	139	139	181
Midwife 10	43	75	80	94	107	113	122	128	131	144	144	177
Midwife 11	41	72	76	90	102	108	116	122	125	139	139	179
Midwife 12	28	96	105	122	107	131	136	139	144	153	153	192
Midwife 13	45	97	90	97	101	103	101	110	119	147	147	175
Midwife 14	39	83	89	91	94	101	110	122	137	151	151	181
Midwife 15	47	83	88	104	118	125	134	141	145	159	159	173

In order to calculate the maximum heart rate possible for each of the midwives studied during physical loads in the process of work for their respective ages, it is necessary to subtract the age from 220, which in the table provided varies from 173 to 192 bpm. For high-intensity physical activity, the heart rate should be about 77% (Riebe et al., 2018, U.S. Dept of Health and Humn Services, 2008) of the maximum heart rate (Figure 1), which shows that 73% (Figure 2), of the midwives experience high-intensity physical strain during the work day, and only 27% experience medium intensity.



	Midwife 1	Midwife 2	Midwife 3	Midwife 4	Midwife 5	Midwife 6	Midwife 7	Midwife 8	Midwife 9	Midwife 10	Midwife 11	Midwife 12	Midwife 13	Midwife 14	Midwife 15
Max. bpm/for day	142	151	133	142	132	141	140	149	139	144	139	153	147	151	159
High intense above 77%	142	136	146	140	139	138	144	141	139	136	138	148	135	139	133

Figure 1. *Distribution of the high-intensity physical activity the heart rate of the studied midwives*

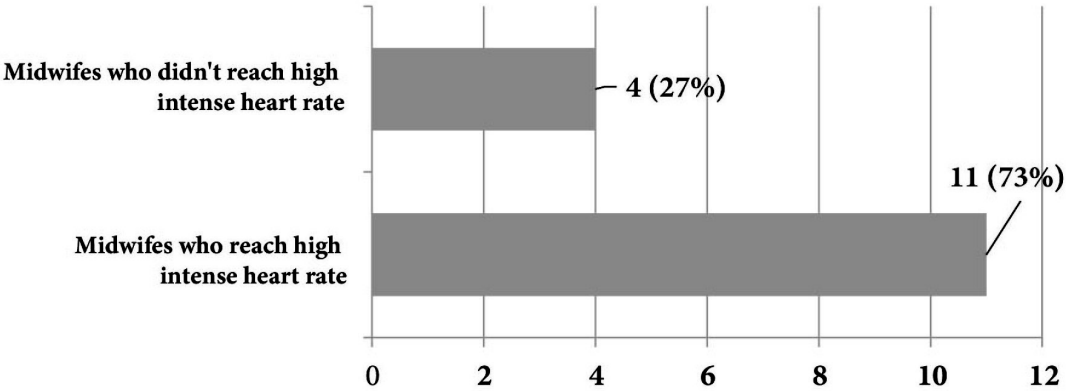


Figure 2. *Percent distribution of reached pulse rate*

The average number of steps the studied midwives make per day is 9373, which is approximately 6.7 km in the span of an 8-hour workday. (Table 2).

According to various sources, medical workers at large hospitals spend most of their time on their feet, aiding multiple patients with various needs.

Table 2. *Number of steps and distance per 8h working days*

	Steps per day	Distance per day/km
Midwife 1	7456	5.32
Midwife 2	10879	7.77
Midwife 3	9346	6.67
Midwife 4	8792	6.28
Midwife 5	9278	6.62
Midwife 6	9465	6.76
Midwife 7	8239	5.92
Midwife 8	8516	6.08
Midwife 9	9742	6.95
Midwife 10	10361	7.40
Midwife 11	9890	7.06
Midwife 12	8052	5.75
Midwife 13	9844	7.03
Midwife 14	9320	6.66
Midwife 15	11423	8.16
Avg. steps/distance	9373	6.70

Due to this reason, they often exceed 10,000 steps (approximately 7 km) during their 12-hour shifts and could perform up to 60,000 steps per week! This means that for the group of health workers that we studied, the average number of steps goes up to 9373 steps (6.7 km) per 8-hour workday, which can qualify as a high level of physical strain and at the end of the work week this level could reach values of overload for the organism.

We calculated the optimal weight for each of the midwives studied by the formula:

$$(\text{height} - 110)*1.15, \quad (1)$$

The results achieved (Figure 3) indicate that 67% of the participants studied are overweight, and the remaining 33% have normal weights. Global obesity levels have doubled in the last 30 years (WHO, 2021). Due to its strong links with chronic illnesses, obesity is one of the most widespread threats to health and well-being.

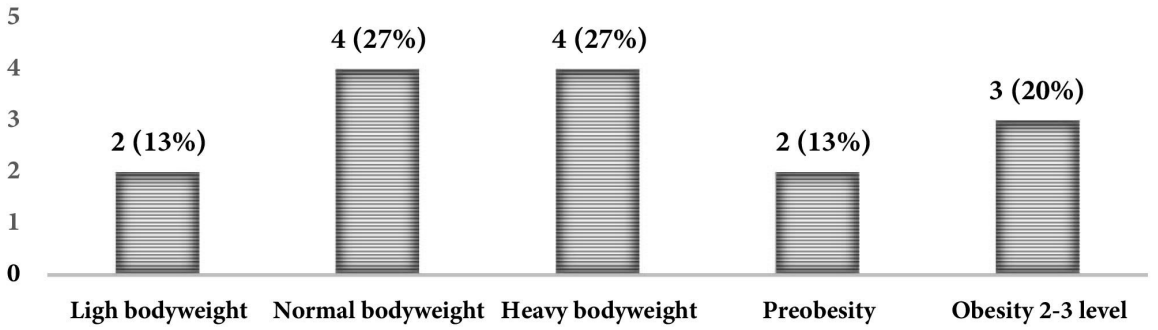


Figure 3. *The weight distribution of the studied midwives*

This indicator can be a significant factor in predicting cardiovascular system problems and the development of diabetes, as their early prevention can lead to improving the quality of life and work for the healthcare system workers in Bulgaria.

DISCUSSION

In the 21st century, people live in a hectic rhythm of work, and many completely forget that health is a core human value. It is vital for midwives to observe the main indications that the body gives, such as weight, heart rate condition, and physical strain to notice promptly, the perspective of future complications.

Analyzing all data from the present survey, we con-

cluded that the physical strains, as high in quantity and intensity as they are, and the high pace of work while working with patients inevitably lead to excessive fatigue and stress among the midwives working in the medical sphere. In order to maintain the level of quality of their work, medical institutions must take adequate measures that include:

- optimization of the work process and improving the work conditions in hospitals
- strict observation of work hours and recess times for health workers (midwives)
- equal distribution of duties among all staff members in the working process.
- minimizing administrative work
- in-service training and professional and technological development of health workers in the sphere of obstetrics.
- adding additional detail to health worker weight measurement to detect and prevent overweight and improve the quality of life for health workers.

The study results provide data for only a small part of the physical loads of midwives in hospitals because, in the wards where the study was conducted, the work process with patients is mainly organized in medical cabinets with day shifts lasting 8 hours. In the other wards of the health facilities, such as neonatology, maternity, and gynecology, the organization of midwives' work with patients is distributed by day and night 12-hour shifts. In these wards, the working environment is significantly more physically demanding and stressful, to which night work also contributes.

CONCLUSION

In conclusion, it can be added that one of the main problems of health care in Bulgaria is that more than 80% of people work in more than one place and very often give two shifts in 24 hours in different health hospitals. This inevitably leads to extreme levels of physical and mental strain, overwork, and stress, which could be the subject of more extensive and in-depth research.

REFERENCES

Hadzhideleva, D. (2014). *Komunikatsii v akusherskite grizhi*, Disertatsionen trud, Sofia.

OSHA. (n.d.)., *Psychosocial risks and stress at work.* Retrieved October 9, 2022, from https://osha.europa.eu/en/themes/psychosocial-risks-and-stress.

Aleksandrova, M. (2007). *Savremenni tendentsii v obuchenieto na meditsinskite sestri*, Sofia.

Borisov, V., Vodenicharov, Ts., Yurukova, K., Popova, S. (2001). *Sotsialna meditsina*, Gorekspres, Sofia, 64-71 str.

Velev, P., Nisheva, V. (2004). Samootsenka na komunikativnite sposobnosti na meditsinskite spetsialisti, *Sestrinsko delo* br. 2/2004 g.

Lazarus, R. S. (1966). *Psychological stress and the coping process.* McGraw-Hill.

Riebe, D., Ehrman, K. J., Liguori, G., Magal, M. (2018). Chapter 6 General Principles of Exercise Prescription. *In: ACSM's Guidelines for Exercise Testing and Prescription*. 10th Ed. Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia, PA: 2018, 143-179.

Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory* Committee Report, 2008. Washington, DC: U.S. Dept of Health and Human Services; 2008.

WHO (2021). *Obesity and Overweight.* Retrieved September 23, 2022, from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

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MENTAL TRAINING OF SAMBO ATHLETES THROUGH APPLICATION OF INSTRUMENTAL METHODS

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ABSTRACT
A number of methods for mental training have been developed and approved in sports practice - progressive muscle relaxation, autogenic training, visualization, mental imagery, and different forms of meditation. In order to be mastered and efficiently used, however, they should be applied continuously and repeatedly. In recent years, the efforts of mental training specialists have been aimed at developing and implementing machine instrumentation methods, which prove to have more powerful effects and accelerate the processes of mental training. The basis of these methods is biofeedback. The aim of this study is to research the impact of cognitive training through machine instrumentation methods on significant for sports performance psychological factors. We used: Thoughtstream Stand-Alone System – a personal biofeedback training system, and Procyon Light & Sound Mind Machine - Full Spectrum Audio-Visual Synthesizer. The research was done among three groups (66 sambo athletes, 49 men, 17 women) with a mean age of 19,2 years (±4.2). Different machine instrumentation methods were applied to the two experimental groups. The first group undertook 10 sessions of a mixed program of 15-minute duration with Procyon Light & Sound Mind Machine. The second group undertook 8 mental training sessions with The Thought Stream Personal Biofeedback System. The third group used autogenous training as a relaxation method. Two measurements were made to evaluate the experiment results – before and after the impact. The indexes of sensorimotor coordination, time-movement anticipation, reaction test, and risk choice behavior were measured. The measurements were made with the help of the Vienna test system.
The comparative analysis (Wilcoxon) establishes significant differences between the first and second testing in the two experimental groups regarding sensorimotor coordination, time anticipation, reaction test, and risk choice behavior. The obtained results from the research show that the apparatus methods for mental training are more efficient than the traditional ones, such as the autogenic training applied in the control group.

Keywords: *sensorimotor coordination, time-movement anticipation, risk choice behavior*

INTRODUCTION

Success in sport is determined in part by physical conditioning skills and preparation. But it is also influenced by psychological factors such as motivation, self-confidence, concentration, and emotional control (Weinberg, Gould, 2019). To enhance the psychological component of physical movement, mental skills training has been recognized as an effective method (Vealey, 2007; Savcheva, 2010, 2011; Williams, Krane, 2021). Primarily, mental skills training has developed from the necessity of the athlete to learn more about their individual mental life to allow a degree of control in coordinating effective movement through various psychological states of performance (Martens, 2012; Williams, Krane, 2021). There are many different methods used to develop mental skills in task performance. Still, most can be separated into two basic approaches, cognitive and somatic, even though there is much overlap. Mental training is a term used to describe the mental techniques necessary for consistently high performance.

A number of methods for mental training have been developed and approved in sports practice - progressive muscle relaxation, autogenic training, visualization, mental imagery, and different forms of meditation. In order to be mastered and efficiently used, however, they should be applied continuously and repeatedly, which constitutes a significant problem.

In recent years, the efforts of mental training specialists have been aimed at developing and implementing machine instrumentation methods, which prove to have more powerful effects and accelerate the processes of mental training. The basis of these methods is biofeedback.
The aim of the present study is to research the impact of mental training through machine instrumentation methods on significant for sports performance psychological factors.

METHOD

1. Procyon Light & Sound Mind Machine (Figure 1) - Full Spectrum Audio-Visual Synthesizer. The Procyon includes 50 unique, pre-programmed light and sound stimulation sequences within its internal memory, each designed with a specific goal in mind.

Figure 1. *Procyon Light & Sound Mind Machine*

2. Thoughtstream Stand-Alone System (Figure 2) - personal biofeedback training system based on skin-galvanic reaction.

Figure 2. *Thought stream Stand-Alone System*

The research was done among three groups (66 sambo athletes, 49 men, 17 women) with a mean age of 19,2 years (±4.2). Informed consent was obtained from the parents of the examined persons under 18 years of age.

Organization: In order to fulfill the aim of the research, a psychological experiment was held. Different machine instrumentation methods were applied to the two experimental groups.

The first experimental group (16 athletes) undertook 10 sessions of a mixed program of 15-minute duration with Procyon Light & Sound Mind Machine.

The second experimental group (18 athletes) undertook 8 mental training sessions with The Thought Stream Personal Biofeedback System.

The third group (a control one – 22 athletes) used autogenous training as a relaxation method.

Two measurements were made to evaluate the experiment results – before and after the impact. The indexes of *sensorimotor coordination, time anticipation, reaction test, and risk choice behavior* were measured**.** The measurements were made with the help of the Vienna test system.

RESULTS

The comparative analysis (Wilcoxon) of the experimental data shows significant differences between the two experimental groups' first and second testing regarding all researched parameters, except for the readiness to take risks – total number of points.

There are also some differences in the control group in part of the researched indexes.

The results from the variation analysis reveal the following trends with the researched variables:

- *Reaction Test* - Measurement of the reaction time to optical and acoustic stimuli. Measurement of the reaction time to visual and auditory stimuli. Apart from recording reaction times down to the millisecond, it also covers the areas of alertness, the ability to repress an inadequate reaction (an area relevant in attention diagnostics), vigilance, and intermodal comparisons (directed attention) in special forms. With the Reaction Test, the reaction time measurement is possible as a single-choice reaction and a simple multiple-choice reaction. The stimulus modalities light/tone and the characteristics red/yellow/white are available so that different stimulus constellations can be produced to measure reaction time. These can go from individual stimuli to simultaneous or sequentially presented stimulus combinations. Using a rest and a reaction key makes the splitting into reaction and motor time possible.

- *Median reaction time RTLP* (Figure 3) *decreases* significantly in both experimental groups (T1=3.726**; (T2=3.514**). The control group's median reaction time increases considerably during the second test (Tк=3.121**).

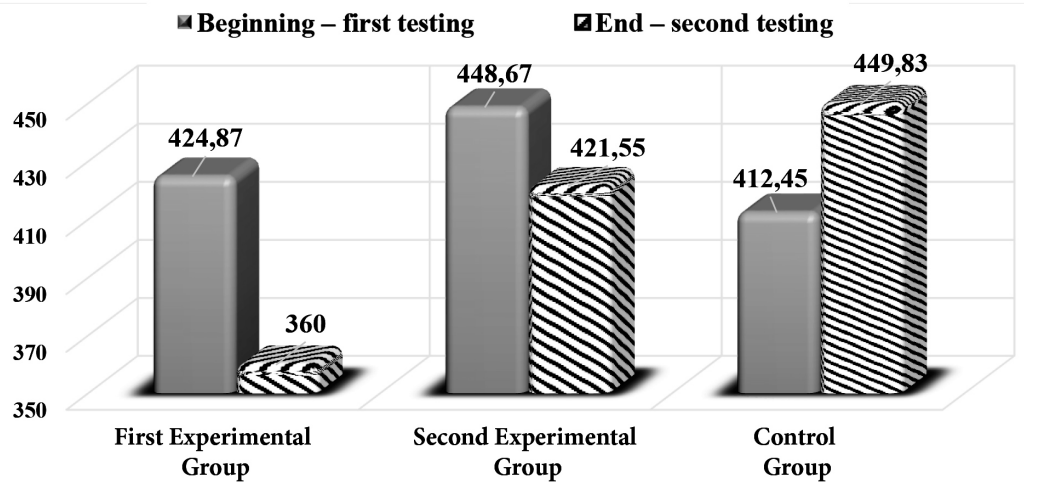

Figure 3. *Mean values of the Median reaction time*

Median motor time RTMP (Figure 4) – analogical trends are observed with the experimental groups (T1=3.513*; T2=3.114*) and with the control group (Tк=3.262*).

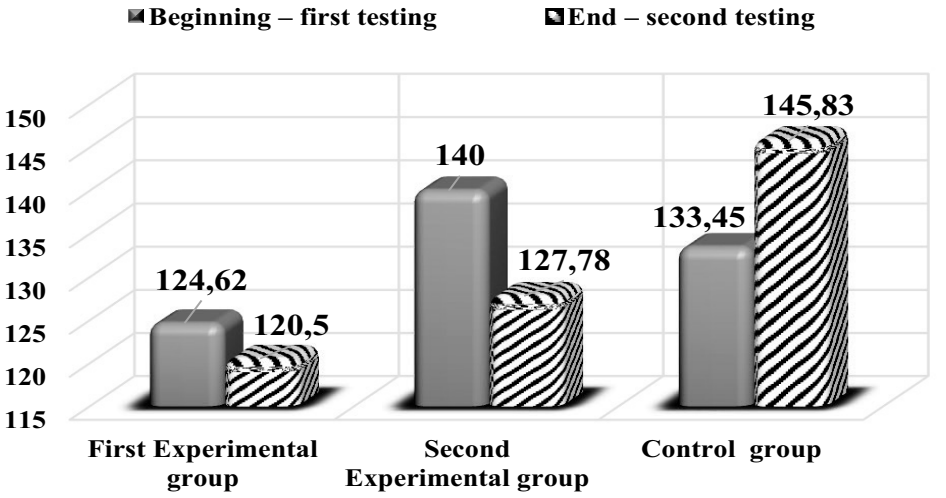

Figure 4. *Mean values of the Median motor time*

Sensomotor coordination SMTK 10 min. This test assesses the coordination of eye-hand, hand-hand, or eye-hand-foot by maneuvering a circular segment that moves on its own about a 3-dimensional room. The assumption is that movements are controlled using sensor information from current activities. The necessary time to coordinate one's movements is essentially determined by the received and processed feedback information. A significant improvement in the results can be observed in the two experimental groups after the applied influences, with the changes in the first group being bigger (T1=3,729**; (T2=3,127**). There was no change in the control group during the second testing (Figure 5).

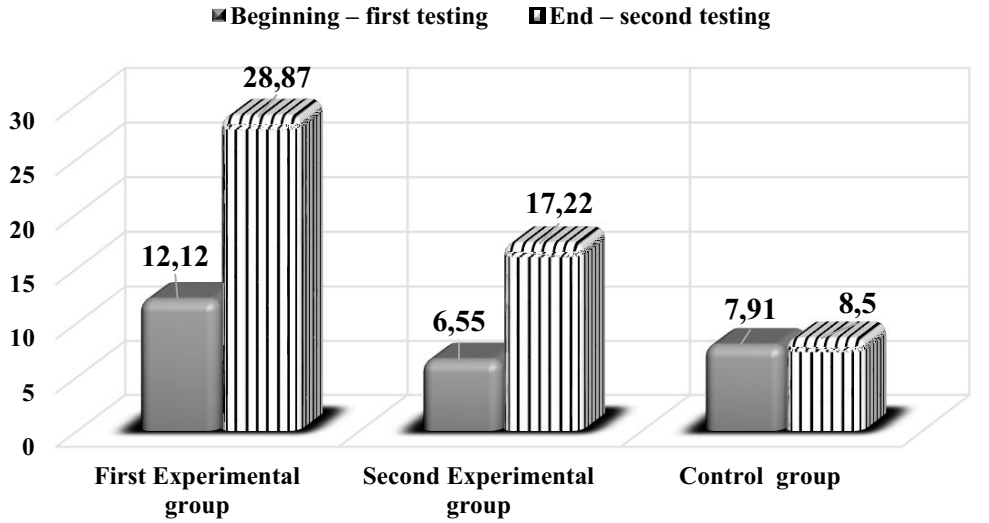

Figure 5. *Mean values of the Sensorimotor coordination*

Time anticipation ZBAT – A function is an extent to which a person can get the feel of a movement and correctly estimate the movement of objects in space. The experiment of moving objects in specific trajectories while executing an eye-movement analysis was terminated due to experiences with eye-movement analyses (Figure 6).

There are significant differences in both experimental groups (T1=3,718**; (T2=3,325**). After the applied influences, the anticipation ability is increased, which is significant for single combat sports, particularly for sambo.

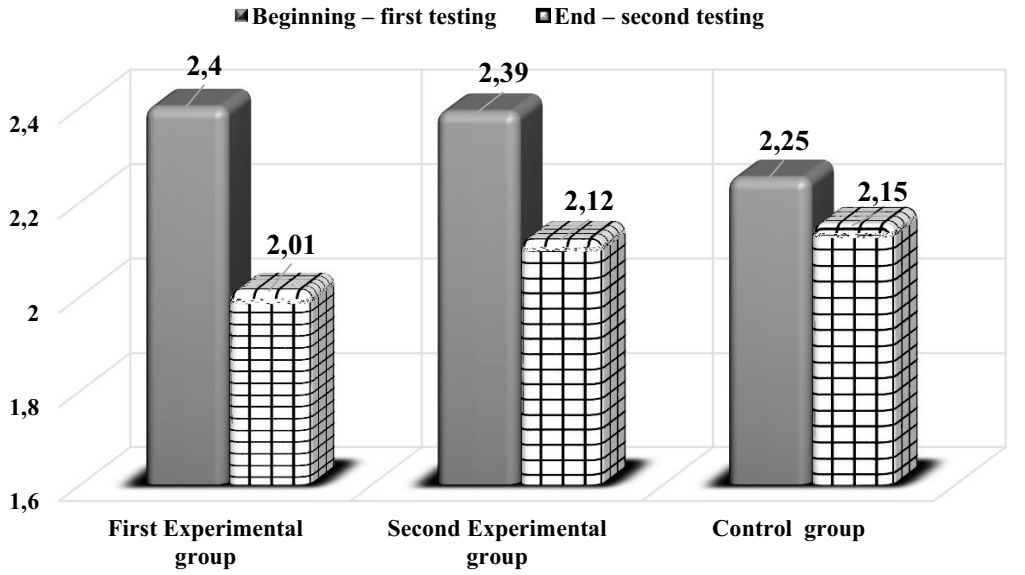

Figure 6. *Mean values of the Time anticipation*

Assessment of general readiness to take risks (RISK). Based on the Risk Choice model of Atkinson (1957) and psychological research into the selection of levels of challenge, the test measures an individual's overall readiness to incur risk by assessing their achievement motivation. This score indicates the extent of an individual's willingness to take risks. The higher the score, the more ready the individual is to take risks (Figure 7).

With the three groups of researched individuals, there is a decrease in the readiness to take risks and a more realistic evaluation of one's abilities during the second testing. The most significant change can be observed in experimental group 1 (T1=3.523**; (T2=3.198**).

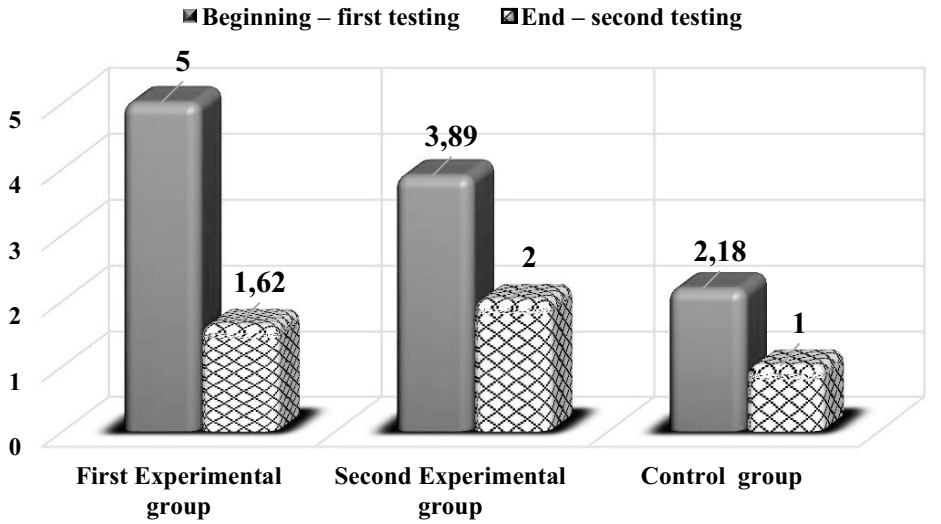

Figure 7. *Mean values of the general readiness to take risks*

Willingness to take risks RISKBALL – total number of points -

These results are confirmed by the total number of points, as well. With the experimental group 1, the achievement motivation increases insignificantly; there is no change in the experimental group 2, while the achievement motivation of the control group decreases (Figure 8).

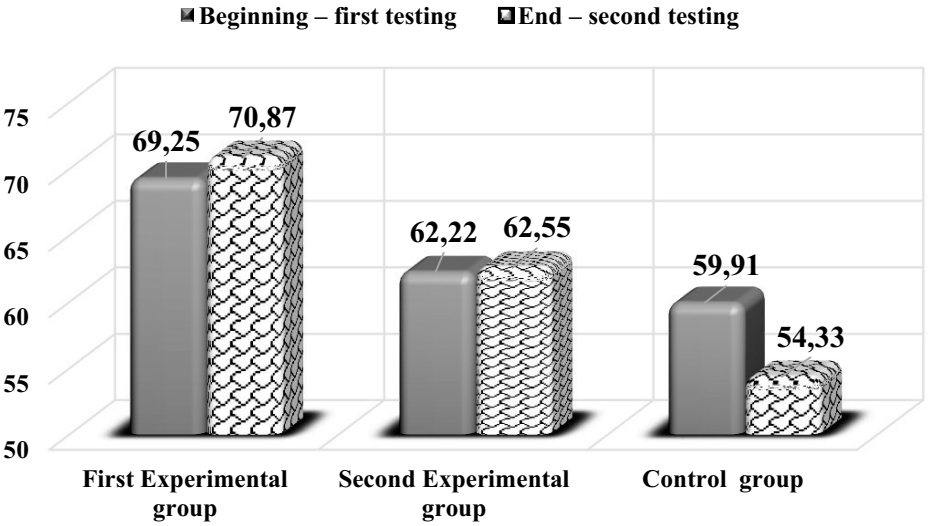

Figure 8. *Mean values of the Readiness to take risks - total number of points*

DISCUSSION

This study examined the impact of mental training through machine instrumentation methods on significant for sports performance psychological factors. The analysis of the results shows that the applied apparatus methods for mental training

improve some of the researched indexes. The comparative analysis establishes significant differences between the first and second testing in the two experimental groups regarding *sensorimotor coordination, time anticipation, reaction test, and risk choice behavior.*

There are some differences in some of the researched parameters in the control group. Still, the changing trend is negative as regards Median reaction time and Median motor time.

CONCLUSIONS

The obtained results from the research show that the apparatus methods for mental training are more efficient than the traditional ones, such as the autogenic training applied in the control group.
Our further research will reveal the influence of machine instrumentation methods for mental training on self-control, self-regulation skills, and the ability to cope with pre-competitive anxiety and stress.

REFERENCES

Birrer, D., Morgan, G. (2010). Psychological skills training as a way to enhance an athlete's performance in high-intensity sports. *Scand. J. Med. Sci. Sports* 20 (Suppl. 2), 78–87. doi: 10.1111/j.1600-0838.2010.01188.

Burton D. & Raedeke T. (2008). *Sport Psychology for Coaches* (Champaign, IL: Human Kinetics).

Martens, R. (2012). *Successful coaching.* Champaign, Illinois: Human Kinetics. ThoughtStream User`s Guide and Reference. (1996). MindPlace Marketing.

Procyon Audio-Visual Synthesizer *TM*. (1998). User's guide and Reference.

Psychological assessment with the Vienna Test System (VTS) https://www.schuhfried.com/vienna-test-system/tests-and-test-sets/ (10.09.2022)

Savcheva, E. (2010). Organization and conduct of mental training for fencers. - In: *Personality. Motivation. Sports*. T.15. NSA-Press, Sofia, pp. 164-171. ISBN 978-954-718-279-9 (in Bulgarian)

Savcheva, E. (2011). Effect of mental training on mental skills in fencers. - In: *Personality. Motivation. Sports.* T. 16. NSA Press, Sofia, pp. 198-207. ISBN: 978-954-718-302-5 (in Bulgarian)

Vealey, R. S. (2007). Mental skills training in sport. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of sport psychology* (pp. 287–309). John Wiley & Sons, Inc.

Weinberg, R.S., Gould, D. (2019). *Foundations of sport and exercise psychology*. Champaign, Human Kinetics.

Williams, J. M., Krane, V., (2021). *Applied sport psychology: personal growth to peak performance*. Eighth edition. New York, McGraw-Hill Education.

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EXERGAMING AND EXERDANCING ENHANCE THE WELL-BEING OF OLDER ADULTS

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ABSTRACT
The digital age and advances in technology are introducing a new attitude to medical care, bringing about significant technologies such as exergames, enhancing the promotion of active and healthy aging. This study aimed to investigate possible differences in perceived quality of life factors between older adults participating in traditional dance and physical training using new technologies, comparing them with sedentary people (control group). The study involved 84 women, with an average age of 67.6 years from Day Care Centers of the Municipality of Thessaloniki, Greece. The program duration was six months (24 weeks) with a frequency of twice a week and each session lasted 75 minutes. An evaluation was performed both before and after the end of the interventions with specialized tools that assess the physical status and functional capacity of the individuals, as well as questionnaires that assess the quality of life indicators. Regarding the usability of the systems, integrated the System Usability Scale (SUS). Statistical analysis was performed with the statistical package SPSS 26. According to the results, the intervention groups compared to the initial measurement showed a statistically significant improvement in variables that assess strength, balance, aerobic capacity, gait to avoid falls, stress, depression, and quality of life in general, in comparison with the control group ($p \leq .05$). The SUS scores ranged around 80 for both systems, so it seems that the practical implementation of the programs has the potential to provide the expected results. In conclusion, these innovative technological solutions in collaboration with expert health professionals, can improve the quality of life of older adults, remain autonomous and independent, but at the same time active members of society for a long time.

Keywords*: older adults, exergames, dance, quality of life, active and healthy aging*

INTRODUCTION

Aging as a social phenomenon concerns every society and various scientific disciplines are trying to deal with it. According to the World Health Organization (WHO), it is one of the most important socio-economic challenges of the 21st century. In 2017, one in eight people worldwide was aged 60 or over and in 2050, older people are expected to represent one in five people worldwide and 35% of the population in Europe (United Nations, 2017). Advanced age, in addition to changes in physical status and functional capacity, increases susceptibility to chronic diseases and disabilities while limiting the quality of life of individuals (Wanderley et al., 2015). As a result, both their problems and their needs need special attention from health professionals and the state itself to try to influence the policies paths so that older adults could live a Healthy Aging.

The European Commission has recognized active and healthy aging as an important social challenge common to all European countries. The pilot program of the European Commission entitled "European Innovation Partnership on Active and Healthy Aging (EIP on AHA)", is an important political initiative for the development of digitization innovation in the field of active and healthy ageing, where it brings together all relevant organizations in order to develop partnerships and coordinate various actions. It is based on several pillars related to care in the elderly such as prevention and early diagnosis, integrated care and treatment, friendly environment for older people and aging and independent living.

The combination between knowledge and the use of technology, aims to develop innovative assistive technologies to improve the lifestyle of older adults, helping them to live healthy, autonomous, and independent (Teh et al., 2017). WHO's Strategy and Action Plan on Aging and Health will help individuals to address potential barriers to their full participation in society with dignity. New opportunities are created to adapt to the ongoing developments in their economic, social, and cultural life. Thus, well-being, safety, protection, and communication, changes, improves, and acquires other stimuli (Rodgers, 2019). Public initiatives, such as active and assisted living, are trying to apply innovative technological solutions to address these needs or even enable the restructuring of healthcare systems for a different delivery of health services in the future (Vassli, Farshchian, 2018).

In the advent of digital technology, exergames,

which combine digital gaming and physical exercise, are commonly used as daily exercise programs (Oh, Yang, 2010). Although initially designed for entertainment, exergames are increasingly being used to promote health. They are a type of exercise based on sensor technologies (cameras, motion sensors and remote controls) in such a way that users are required to move to fully interact and have the best experience during the game (Donath et al., 2016). They offer the possibility to users to improve their motor and cognitive functions through an interactive way (Skjaeret et al., 2016). In addition, they enhance socialization and improve the individual's self-confidence to function autonomously in daily activities (Konstantinidis et al., 2016; Zilidou et al., 2016).

Reforming health systems with applications of modern technology could bring in the activation of older adults. The goals of each program may vary, but all researchers focus on improving the individual's physical and mental well-being. A good practice constitutes the integrated healthcare system LLM Care (www.llmcare.gr), an integrated online platform where it combines the most modern cognitive exercises with physical activity, in the context of an advanced assisted living environment (AAL), with the use of serious games, promoting their physical and cognitive health (Bamidis et al., 2015). It consists of two programs, the program BrainHQ (www.gr.brainh.com), which includes cognitive training techniques, particularly effective in speeding up and sharpening visual and auditory processing and the program webFitForAll (www.fitforall.gr) which is a game platform that includes specially designed exercise protocols for people belonging to vulnerable groups, enhancing their physical status and functional abilities through a motion detection device. LLM Care is a unique example of a living/dynamic social laboratory of active and healthy aging (http://www.aha-livinglabs.com) and a reference site of the European Innovation Partnership on Active and Healthy Aging - EIP on AHA) for the distinction of highlighting excellence in the development, but also in the adoption and scaling of innovative practices and digital solutions for active and healthy aging.

The connection between dance and technology began when dance teachers and researchers used video to record dances and media to store them (Birringer, 2002). However, research into the impact of technology in dance education is in its early stages. Dance learning applications strive to be highly innovative; the interest of experts has shifted to using the internet to merge choreography with virtual environments (Thorne et al., 2009). Distance education as a result of the development of technology and communication, is a tool for flexible forms of learning, education and training (Κανελλόπουλος, Κουτσούμπα, 2019).

Assistive technologies allow people with health problems to function to the best of their abilities both educationally and socially in their daily activities. The aim of this study was to investigate possible changes in variables of perceived quality of life among older adults who participate in Greek traditional dance groups, or aerobic exercise, with the use of new technologies in various digital environments, comparing them with people who they lead a sedentary life.

METHODS

Participants

A total of 84 women were evaluated with an average age of 67.6 years at the Day Care Center of the Municipality of Thessaloniki, Greece. Participants did not have significant motor (upper or lower limbs) or serious cardiovascular problems. Participation in the research was voluntary, they consented to be included in the study, photographed, and videotaped, and had the right to withdraw from the study at any time without obligation. Their personal data was protected using a pseudonym during the publication and dissemination of the results. At the beginning and after the end of the interventions, all participants were assessed for their physical status and functional capacity.

Intervention and control groups

Three groups were in this study, two formed the intervention groups, Dance and Physical groups while a third formed the control group. The duration of the programs was six months (24 weeks) with a frequency of twice a week and a session duration of 75 minutes. Specifically:

a. Dance group (Figure 1): dances were selected from different regions of Greece and classified into three categories: mild, moderate, and high intensity. The material used for the implementation of the dance program was established on a web-based course management system (Tsiatsos et al., 2010), on the Moodle platform (http://

moodle.org). It was posted on the platform on the website "Traditional Dances" (http://ellinikoixoroi.phed.auth.gr/) and contained the basic ethnographic elements of the dance as a theoretical framework (origin, rhythm, hands position), and three videos used for the demonstration and training of the practical part of the dance.

Figure 1. *Dance group intervention*

b. Physical group (Figure 2): used the online physical program webFitForAll (www.fitforall.gr) where it included the four basic types of exercises: aerobic capacity, strength, balance and flexibility. The training protocol was designed according to the guidelines of the American College of Sports Medicine (ACSM).

Figure 2. *Physical group - webFitForAll intervention*

c. Control group: they did not perform any type of intervention.

In Table 1 below are the demographics of the groups:

Table 1. *Demographics of groups*

Groups	N	Gender	Mean Age	SD	Standard error
Physical	25	F	68.60	4.500	.900
Dance	27	F	67.37	4.369	.841
Control	32	F	66.84	5.870	1.038

The specialized tools used to assess the physical status and functional capacity of the participants are: Senior Fitness Test – SFT, Berg Balance Scale (BBS), Tinetti test and Stork Balance, while questionnaires were used to assess quality of life indicators such as Geriatric Depression Scale-GDS, Beck Anxiety Inventory (BAI), Friendship Scale, Personal Risk Factors and WHO-QOL. The System Usability Scale (SUS) was used to measure the usability of the systems.

Statistical Analysis

The statistical analysis was performed with the Statistical Package, SPSS 26. Descriptive analysis was performed using frequency analysis, means, standard deviations, t - test and One-way Anova. Statistical significance level was set at p = .05.

RESULTS

An independent samples t-Test statistical analysis was performed to assess the differences between the measurements on each variable for each group and the results are shown in Table 2 below.

Table 2. *Differences between the assessments on each variable for each group*

Variables	Mean	SD	Standard error	t	df	Sig. (2-tailed) Physical	Sig. (2-tailed) Control	Sig. (2-tailed) Dance
Balance_1leg_pre-post	-14.297	19.673	3.786	-3.776	26	**.005**	.398	**.001**
Chair_Stand_pre-post	-2.148	1.680	.323	-6.643	26	**.001**	1.000	**.000**
Arm_Curl_pre-post	-3.444	3.367	.648	-5.316	26	**.001**	.625	**.000**
Two_Minute_Step_pre-post	-13.556	15.485	2.980	-4.549	26	**.004**	.001	**.000**
Sit_And_Reach_pre-post	-2.370	4.491	.864	-2.743	26	.079	.114	**.011**
Back_Scratch_pre-post	-.148	4.704	.905	-.164	26	**.030**	.017	.871
Foot_Up_and_Go_pre-post	.366	.590	.114	3.222	26	**.001**	.304	**.003**
Berg Scale_pre-post	-1.556	1.340	.258	-6.033	26	**.000**	.856	**.000**
Tinetti_pre-post	-.407	.844	.162	-2.508	26	**.003**	.701	**.019**
SF12_PCS_pre-post	-3.730	5.792	1.115	-3.346	26	**.032**	.042	**.003**
SF12_MCS_pre-post	-3.134	6.191	1.191	-2.630	26	**.012**	.386	**.014**
BECK_pre-post	1.815	2.718	.523	3.469	26	.290	.931	**.002**
Friendship_Scale_pre-post	-.704	1.772	.341	-2.064	26	**.039**	.786	**.049**
Risk_Falls_pre-post	-.148	.770	.148	-1.000	26	1.000	.026	.327
WHOQOL_pre-post	-9.222	6.776	1.304	-7.072	26	**.000**	-	**.000**

In the SUS test, which is a tool for measuring system usability, the Physical group showed a performance of 80.3 while the Dance group showed a performance of 79.81 (Table 3).

Table 3. *Score of System Usability Scale (SUS)*

Group	N	Mean	SD	Standard error	
Κλίμακα SUS	Physical	25	**80.30**	6.05186	1.21037
	Dance	27	**79.81**	9.45449	1.81952

DISCUSSION

The present study aimed to investigate whether dance and physical training programs using technology could have positive effects on the perceived quality of life of older adults, comparing them to sedentary individuals. Evaluating the data, the following summarizes the conclusions for the intervention groups:

The intervention groups, Physical and Dance, in relation to the participants' initial assessments, shown that significantly improved static balance (Balance 1 leg, p=.005 & p=.001 respectively), upper and lower limb strength (Chair stand, Arm Curl, p=.001 & p=.000), aerobic capacity (Two Minute Step, p=.004 & p=.000), dynamic balance and walking agility (Foot Up and Go, p=.001 & p=.003), balance and fall avoidance (Berg Scale, p=.000), walking balance (Tinetti, p=.003 & p=.019), physical (SF -12 PCS, p=.032 & p=.003) and mental (SF-12 MCS, p=.012 & p=.014) health, sociability (Friendship Scale, p=.039 & p=.049) and quality of life in general (WHO-WOL, p=.000). Also, Physical group improved their flexibility in the shoulder (Back Scratch, p=.030), as well as Dance group improved their flexibility in the lower back and hamstring (Sit and Reach, p=.011) and anxiety (Beck, p=.002). The intervention groups, in relation to the Control group, presented significant statistical results.

The SUS scale, which evaluates the usability of the systems, showed a performance of 80.3 for the Physical and 79.8 for the Dance group. The average of SUS score is 68. Systems rated below 68 need redesign and more development. Whereas those rated above 68, it seems that the need for improvements is small and can be made much more easily. According to Bangor and his colleagues (2008), the

scores that ranging around 80, it seems that they are good and acceptable and that their practical application has the potential to provide the expected results.

Interventions using technology have been shown to be effective in increasing and maintaining physical activity (Müller, Khoo, 2014). Exergames, (e.g., via MS Kinect and Nintendo Wii), report results on improvements through the combination of mental and physical exercise in the severity of neurocognitive impairment (Bamidis et al., 2015) as well as improved physical functioning, reduced depression, improved socialization, and increased motivation to exercise (Chao et al., 2014).

Dance is an attractive intervention for socialization which contributes to maintaining a positive psychology. The results agree with that presented by Zilidou et al., (2019) about the improvement of aerobic capacity, fall risk, depression, and socialization. Dance offers a variety of intensity and rhythm, as well as creating a pleasant atmosphere during practice (Douka et al., 2019a) and the technology seemed to have a reinforcing effect, showing very good outcomes.

Sedentary life is the enemy of healthy and active aging. The person in good health feels able to live autonomously and independently. Sedentary life, translated as the modern, automated way of life, leads to many problems and ailments. Mainly in diseases related to cardiovascular diseases that cause complex disorders, such as obesity, diabetes, but also in musculoskeletal diseases, such as osteoporosis. According to the symptomatology, the lack of strength, the obvious signs of depression, but also the problems in balance, mobility, endurance, flexibility, appear more often. Sedentary behavior is associated with mortality, risk of depression, and adverse effects on health and well-being in older adults (Rezende et al., 2014).

The assessment of quality of life using technology is the most necessary tool for recording, collecting, and processing data by researchers. They have as a guideline the design of new protocols and tools, as well as applications, that will respond to the problems and needs of older adults. Considering that older adults are active in the society, its dynamics must also be reshaped in terms of the way of education, to acquire various skills that will allow them to participate actively in the new digital society.

Technologies provide sustainable and innovative interventions that can be adapted to support the different health needs of older people and this study was based on these. The findings from the results seem very encouraging as well as beneficial for the intervention groups that used the technology. The technological interaction is inexhaustible, not only in terms of social ramifications, how the person affects in relation to others, but also on a personal level, since now the influential character of technology transfers the up till now known way of learning to new standards. The physical presence of the teacher is no longer necessary for the older adults to receive new knowledge, such as e.g., his personal training. Once he acquires the new skill of using technology correctly, he can apply it to many aspects and activities of his daily life.

REFERENCES

Aalbers, T., Baars, M.A.E., & Rikkert, M.O. (2011). Characteristics of effective internet-mediated interventions to change lifestyle in people aged 50 and older: a systematic review. Ageing Research Reviews. 2011;10(4):487–497. doi: 10.1016/j.arr.2011.05.001.

Bamidis, P. D., Fissler, P., Papageorgiou, S. G., Zilidou, V., Konstantinidis, E. I., Billis, A. S., et al. (2015). Gains in cognition through combined cognitive and physical training: the role of training dosage and severity of neurocognitive disorder. Front. Aging Neurosci. 7:152. doi: 10.3389/fnagi.2015.00152.

Bangor, A., Kortum, P., & Miller, J.A. (2008). The System Usability Scale (SUS): An Empirical Evaluation, International Journal of Human-Computer Interaction, 24(6).

Birringer, J. (2002). Dance and Media Technologies. Performing Arts Journal 70. (2002): 84-93.

Chao, -Y.Y., Scherer, Y. K., Wu, Y.-W., Lucke, K. T., & Montgomery, C. A. (2013). The feasibility of an intervention combining self-efficacy theory and Wii Fit exergames in assisted living residents: A pilot study. Geriatric Nursing (New York, N.Y.), 34(5), 377–382. doi: 10.1016/j.gerinurse.2013.05.006.

European Innovation Partnership on Active and Healthy Ageing. (2022). Retrieved September 10, 2022, from https://ec.europa.eu/eip/ageing/actiongroup_en.

Oh, Y & Yang. (2010). Defining exergames & exergaming. Meaningful Play 2010; October 21 - 23; East Lansing, MI, USA.

Donath, L., Rössler, R., & Faude, O. (2016). Effects of Virtual Reality Training (Exergaming) Compared to

Alternative Exercise Training and Passive Control on Standing Balance and Functional Mobility in Healthy Community-Dwelling Seniors: A Meta-Analytical Review. Sports Med. 2016;46(9):1293-1309. doi:10.1007/s40279-016-0485-1.

Douka, S., Zilidou, V.I., Lilou, O. & Manou, V. (2019a). Traditional Dance Improves the Physical Fitness and Well-Being of the Elderly. Front. Aging Neurosci. 11:75. doi: 10.3389/fnagi.2019.00075.

Κανελλόπουλος, Α., & Κουτσούμπα, Μ. (2019). Η έρευνα για την τηλεδιάσκεψη στην εξ ΑΕ. Μία βιβλιογραφική ανασκόπηση. Open Education-The Journal for Open and Distance Education and Educational Technology, 15(2), 54-77. Doi: http://dx.doi.org/10.12681/jode.21619.

Konstantinidis, E.I., Billis, A.S., Mouzakidis, C.A., Zilidou, V.I., Antoniou, P.E., & Bamidis, P.D. (2016). Design, implementation and wide pilot deployment of FitForAll: an easy to use exergaming platform improving physical fitness and life quality of senior citizens. IEEE Journal of Biomedical and Health Informatics, Vol 20 (1), Pages: 189 - 200, doi 10.1109/JBHI.2014.2378814.

Müller, A.M., & Khoo, S. (2014). Non-face-to-face physical activity interventions in older adults: a systematic review. International Journal of Behavioral Nutrition and Physical Activity. 2014;11(1) doi: 10.1186/1479-5868-11-35. Article 35.

Rezende, L.F.M., Rey-López, J.P., Matsud, V.K.R., & Luiz, O.C. (2014). Sedentary behavior and health outcomes among older adults: a systematic review. BMC Public Health. 2014;14(1):333. doi: 10.1186/1471-2458-14-333.

Rodgers, E. (2019). Training older adults to use technology: Facing the challenges. (Order No. 13421413). Available from ProQuest Dissertations & Theses Global, Retrieved from https://search.proquest.com/docview/2212901652?accountid=8359.

Skjaeret, N., Nawaz, A., Morat, T. et al. (2016). Exercise and rehabilitation delivered through exergames in older adults: an integrative review of technologies, safety and efficacy. Int J Med Inform 85:1–16.

Teh, P. L., Lim, W. M., Ahmed, P. K., Chan, A. H., Loo, J. M., Cheong, S. N., & Yap, W. J. (2017). Does power posing affect gerontechnology adoption among older adults? Behaviour & Information Technology, 36(1), 33-42.

Thorne, S.L., Black, R.W. & Sykes, J.M. (2009). Second Language Use, Socialization, and Learning in Internet Interest Communities and Online Gaming. Modern Language Journal, 93: 802-821. DOI: 10.1111/j.1540-4781.2009.00974.x.

Tsiatsos T., Stavridou E., Grammatikopoulou A., Douka S., & Sofianidis G. (2010). Exploiting Annotated Video to Support Dance Education. In Proceedings of Fifth International Conference Web Applications and Se, ICIW 2010, p.100-105.

United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Ageing 2017 - Highlights (ST/ESA/SER.A/397).

Vassli, L. T., & Farshchian, B. A. (2018). Acceptance of health-related ICT among elderly people living in the community: A systematic review of qualitative evidence. International Journal of Human–Computer Interaction, 34(2), 99–116. https://doi.org/10.1080/10447318.2017.1328024.

Wanderley, F., Oliveira, N., Marques, E., Moreira, P., & Carvalho, J. (2015). Aerobic versus resistance training effects on health-related quality of life, body composition and function of older adults. J. Appl. Gerontol. 34, NP143–NP165. doi:10.1177/0733464812468502.

Zilidou, V.I., Ziagkas, E., Konstantinidis, E.I., Bamidis, P.D., Douka, S., & Tsiatsos, T. (2019). Integrating Technology into Traditional Dance for the Elderly. In: Auer M., Tsiatsos T. (eds) The Challenges of the Digital Transformation in Education. ICL 2018. Advances in Intelligent Systems and Computing, vol 917. Springer, Cham. doi:10.1007/978-3-030-11935-5_28.

Zilidou, V., Konstantinidis, E., Romanopoulou, E., Karagianni, M., Kartsidis, P., & Bamidis, P. (2016). Investigating the effectiveness of physical training through exergames: focus on balance and aerobic protocols. In 1st International Conference on Technology and Innovation in Sports, Health, and Wellbeing (TISHW), Vila Real, Portugal.

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ONLINE EXAMS AND THE USE OF DISHONEST PRACTICES BY STUDENTS FROM A SPORTS UNIVERSITY

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ABSTRACT
Dishonest methods have been part of the educational process and are likely to be in the future. However, technological progress has undoubtedly created several preconditions for unfair methods. Over the years, many studies have been conducted, and some models have been validated to assess unethical methods that evaluate different approaches. The present study investigates whether and to what extent students studying in sports-oriented courses use such methods. A literature study was conducted to summarize current research on the topic and provide a basis for creating a questionnaire for the students of the National Sports Academy "Vassil Levski". The survey included 89 participants (38 women and 51 men) in a full-time study. The questionnaire was distributed through the National Sports Academy "Vassil Levski" (NSA) professors during the summer examination session. Participation in the survey was optional and only after the end of the student's examination. The survey was conducted in May-June 2022. The questionnaire was analyzed using Cronbach's α, which showed high-reliability (= .82). Regarding the factors of gender and faculty, no statistically significant differences were found. 30.3% (n=27) of the students responded that they had used a dishonest method and the remaining 69.7% (n=62) declared that they had not used such methods. The most common method is that of using study materials (textbooks) or notes. The following preferred method is "help by a colleague". A correlation was found for those students who used dishonest methods that they boasted to their colleagues r = .758 (α ≤ .001) and their relatives r = .711(α ≤ .001). As a major conclusion, it can be inferred that despite the dishonest methods used by the students, it generally does not lead to their desired assessment and outcome. Using more components to form a student's final examination grade, such as exam grades from evaluations, assignments, or tests, ensures a more realistic final examination grade in the respective subject.

Keywords*: academic integrity, cheating, academic dishonesty, online exam, sports, and physical education*

INTRODUCTION

Many educational institutions faced the problem of providing quality education during the COVID-19 pandemic. As an integral part of this education is conducting testing and assessment in an electronic environment. The issue of online examination and dishonest methods had been explored long before the pandemic. Still, the transition to fully online testing has intensified this process in an avalanche-like manner and has made it slightly easier for learners to turn to some dishonest methods. Many behaviors, attitudes, and reasons were explored long before the education system had access to technology. Dishonest methods have been part of the educational process and are likely to be in the future. However, technological progress has undoubtedly created several preconditions for unfair methods. In 2018, Peytcheva-Forsyth, Aleksieva, and Yovkova (2018) reached similar conclusions, presenting in their research that technical progress and the enormous digital opportunities available to today's students predispose them to non-ethical behavior.

Over the years, many studies have been conducted, and some models have been validated to assess unethical methods that evaluate different types of approaches. One of the more recent models is the Academic Dishonesty Scale (ADS), published in 2018 by authors Bashir and Bala (Bashir & Bala, 2018). Another model is that of Barbaranelli et al. 2018, which is a Mediational and Interactional Model. One of the significant and interesting models is that of McCabe and Trevino (1993), which was subsequently adapted by Iyer and Eastman (2006), again considering the academic dishonesty scale. In general, these models are distinguished into two dimensions. The first relates to cheating (which has been investigated in exam performance), and the second refers to plagiarism (submitting others' or modified homework and papers). In 2008, Iyer and Eastman improved on the previous scales, and electronic cheating and seeking help from others are now included. In 2004, the Self-Report Cheating Scale (Paulhus, Williams, and Nathanson 2004) was developed as an unpublished instrument but was subsequently used by the same author team in 2010. It distin-

guishes three subscales - Unmitigated Achievement, Fear of Punishment, and Moral Inhibition. The reasons for students' academic dishonesty are many and varied and stem from personal intrinsic or extrinsic factors (Amzalag, Shapira, & Dolev, 2022).

Research has been done on whether the gender of learners has an influence or their background, race, or maturity. However, the authors generally cannot reach a consensus, which is probably due to multiple factors that influence and change over time. Probably also to too many options provided.

An interesting theory is also presented by Anderman and Won (2017). They present the relations of academic motivation and personality variables to academic cheating, specifically examining the roles of these variables in disliked classes. Their study concludes that sensation-seeking is the main predictor of cheating in disliked classes. Students with a high need for sensation may be particularly vulnerable to giving in to the temptation to cheat in highly disliked courses (Anderman & Won, 2017).

Maeda (2019) has observed that the student's relationship with the teachers has a crucial influence on academic integrity. The author also found that teachers' low interest in students' depth of learning, which also results in a poor pedagogical style, could be an important reason that motivates students to participate in any kind of unethical behavior (Maeda, 2019) (Noorbehbahani et al., 2022).

When conducting online exams on the virtual.nsa.bg distance learning platform, the impression was created in the academic community that online exams, as a rule, end with their successful completion, that the success rate of exam sessions as a whole increased significantly and that the number of students who successfully passed their exams increased enormously during the period of online exam sessions compared to face-to-face exams. In a study by Miladinov, Kuleva, and Konchev (2022), this theory was rejected, proving that the estimates do not differ significantly. No significant differences were found between the number of students who passed their exams and the mean scores obtained between the face-to-face and distance examination sessions.

The present study examines to what extent the university students from the National Sports Academy "Vassil Levski", Sofia used unfair methods to obtain grades during the examination sessions conducted electronically. The methods they chose to use, and their satisfaction is also the aim of this study.

METHODOLOGY

For this study, a literature review was conducted on the topic of the use of dishonest methods in online examinations. Over 150 literature sources and more than ten models and surveys used by authors to study dishonest methods were examined. The databases used to find literature sources were Web of Science, Scopus, Google Scholar, EBSCO, Science Direct, and others. The leading search criteria were that the articles were in English and contained full text. The year of the study was not of importance, but the keywords that were used to select the articles were. Those that were used in the study were "academic dishonest*" OR "academic cheat*" OR "plagiari*" OR "academic integrity" AND "online exam*" OR "online education" OR "e-learning". If the articles looked at dishonest methods outside the online environment and the evaluation models proposed in them were not taken into account.

Protocol

The questionnaire that was used to collect the responses from the students was created by the author and adapted to the needs of the specific educational institution. A ready-made questionnaire from some of the studies was not used. Overall, ideas were borrowed based on the research articles reviewed. The survey was conducted in May-June 2022. The questionnaire was distributed through the National Sports Academy "Vassil Levski" (NSA) professors during the summer examination session. Participation in the study was optional and only after the end of the students' examination. To conduct the survey, students were asked to scan a QR code that led them to an online form in Google Forms. For the study, the prepared questionnaire was completely anonymous and untraceable so as to be tied to a specific student.

The questionnaire contained 19 questions. The first three questions in the survey were about gender, year of study, and faculty. Two of the questions

were open-ended, and the remaining 13 questions were closed-ended with answers of "yes" or "no" or "yes", "rather yes", "rather no", and "no".

Participants

The survey included 89 participants (38 women and 51 men) in a full-time study. The students were from all three faculties of NSA "Vassil Levski" and all years of study (1st - 4th year). Due to the specificity of the topic, some of the students who were offered to complete it refused due to concerns about being disclosed.

Statistical methods

MS Excel and IBM SPSS v.19 were used for statistical processing. To check the reliability and validity of the questionnaire and to measure the internal consistency, a Reliability test was performed, which showed that Cronbach's α = .82, which is acceptable reliability and can be reported as high (Cronbach, 1951). Frequency analysis, Crosstabs, and Pearson's coefficient of correlation were used.

Specification and technical characteristics of the NSA "Vassil Levski" examination system.

In the testing system, students take quizzes based on pre-set exam templates for the specific course material studied during the semester. These templates consist of a number of questions entered into the system and generated by the professor. The professor can choose to have specific or random questions from a particular subject area. He can also do a combination – of specific questions and random questions. The order of the questions is shuffled, with the system automatically selecting questions randomly from a given topic and the created "question bank". The possible answers are also shuffled so that it is almost impossible for two students to have the same questions and possible answers. The time for the exam is set by the professor, who starts the exam at the same time for all students. Once the student enters a password in their account, their individual exam time starts.

RESULTS AND DISCUSSION

After applying Cronbach's alpha test, it indicated good internal reliability (α= .82). So, the reliability analysis suggests that the questionary is internally consistent. The application of factor analysis was not the aim of this study but to establish the relationships and the general picture regarding students' use of dishonest methods.

Regarding the factors of gender and faculty, no statistically significant differences were found.

Table 1 also shows the distribution of students by year of study and the faculty in which they are studying. The highest percentage of responding students were those in the third year of study, followed by those in the second year of study. This is quite logical as they also have the most experience as learners during the COVID-19 pandemic. The distribution by faculty, in general, also corresponds to the overall picture of students enrolled at NSA „Vassil Levski".

Table 1. *Percentage distribution of students by year of study and faculty*

Year of the study	**Frequency**	**Percent**
First-year students	5	5.6 %
Second-year students	37	41.6 %
Third-year students	45	50.6 %
Fourth-year students	2	2.2 %
Faculty of the students	**Frequency**	**Percent**
Sports Faculty	61	68.5%
Physical Education Faculty	26	29.5%
Faculty of Public Health, Health Care and Tourism	2	2.2%

The study found that only 4.5% of the students surveyed had not taken an online exam during their studies, and these were first-year students. This could be explained as responses received from older students who did not take classes during the pandemic or those who did not participate in online exams during the winter semester for whatever reason.

Of particular relevance to the overall study is whether students have used an unfair method

during the online exams they have taken so far at NSA "Vassil Levski". 30.3% (n=27) responded that they had used a dishonest method and the remaining 69.7% (n=62) declared that they had not used such methods.

Table 2. *Frequency distribution of dishonest methods used when taking an online exam.*

Methods used	Used method	Not used method	Used only for some of the questions
Textbook, notes	12.4% (n=11)	59.6% (n=53)	28.1% (n=25)
Help from colleagues	12.4% (n= 11)	74.2% (n=66)	13.5% (n=12)
Help from relative	11.2% (n=10)	75.3% (n=67)	13.5% (n=12)
Had the exam questions	7.9% (n=7)	80.9% (n=72)	11.2% (n=10)
The assignment is done by another person	10.1% (n=9)	89.9% (n=80)	-
Another person took the exam	10.1% (n=9)	89.9% (n=80)	-
I paid another person to take the exam	7.9% (n=7)	92.1% (n=82)	-

From what is shown in Table 2, the most common method is that of using study materials or notes. The following preferred method is prompting/ help by a colleague. The third is help from a relative or close friend. About 10% of the students also used a dishonest method by passing off someone else's work as their own.

A Crosstab analysis found that students were generally dissatisfied with the grades obtained despite the dishonest methods used, a trend regardless of the method used. This could be explained by the fact that the system used and the questions used by the lecturer ensure the reliability of the examination process. Suppose students use notes or a textbook during the exam. In that case, if they are not prepared and have not read up on the exam topic beforehand, they may find it difficult to navigate where to find the information they need during the exam itself.

On the other hand, those students who used homework or assignments prepared by someone else were more likely to be satisfied with the grade received. This form of plagiarism is also a dishonest practice, and addressing this problem could be solved by introducing strict rules for detecting such dishonest practices. This could be done by using many software applications to check for similarities, and this approach is particularly appropriate for digital texts and homework. Marshall & Varnon came to similar conclusions in their research published in 2017. They suggest that integrating online courses without rules for ethical behavior suitable for the online environment and special techniques to prevent academic dishonesty provides fertile ground for an increase in the frequency of inappropriate academic behavior (Marshall & Varnon, 2017).

The questionnaire asked whether students felt guilty about the unfair method they used. The data showed that a large proportion of those who used unfair practices (approx. 60%) during online exams felt no guilt about it.

Table 3. *Correlation table of the studied indicators*

	Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1	Use of a dishonest method	1												
2	Textbook	.338**	1											
3	Help/guidance from colleagues	.481**	.460**	1										
4	Help/guidance from a relative	.409**	.499**	.689**	1									
5	Has solved exam questions	.440**	.411**	.620**	.542**	1								
6	Using someone else‘s homework or assignment	.346**	.383**	.673**	.595**	.725**	1							
7	Another person took the exam	.346**	.383**	.673**	.650**	.662**	.876**	1						
8	I paid another to take the exam	.261*	.373**	.620**	.587**	.569**	**.733****	**.871****	1					
9	Estimated grade received	**.613****	.599**	**.667****	.540**	**.653****	**.633****	.566**	.489**	1				
10	Problem when introducing video surveillance	.024	.219*	.024	.226*	.015	.056	.153	.203	.200	1			
11	Experiencing guilt	.305**	.313**	.237*	.440**	.150	.076	.194	.267*	.301**	.445**	1		
12	Colleagues know about used dishonest methods	**.758****	.430**	.571**	.390**	.581**	.440**	.358**	.271*	**.676****	.023	.375**	1	
13	Relatives know of dishonest methods used	**.711****	.419**	.533**	.392**	**.628****	.415**	.335**	.251*	**.638****	.047	.415**	**.895****	1

***. Correlation is significant at the 0.01 level (2-tailed)*
**. Correlation is significant at the 0.05 level (2-tailed)*

Pearson's coefficient of correlation demonstrated higher levels of significance at Sig. $\alpha \leq .001$ for some of the questions. The correlation was found that those students who used dishonest methods boasted to their colleagues r = .758 and their relatives r = .711. It is also found to have a very high correlation that if the colleagues know, the relatives also learn about the unfair methods used.

In his research, Maeda finds a strong relationship between students' moral attitudes toward cheating and their level of participation in academic misbehaviors (Maeda, 2019). The present study found a low correlation between guilt and the dishonest methods used. Compared to university colleagues, it was r = .375 ($\alpha = .000$), and compared to parents, it was r = .415 ($\alpha = .000$).

The moderate correlation found with the exam score was shared with colleagues r = .676 and relatives r = .638. This, to some extent, justifies the reason for the dishonest methods used - the grade is relatively important to colleagues and parents. Again, Maeda finds that Parents' acceptance of cheating behaviors massively affects the student's mindset toward these behaviors.

It was also found that by using the unfair method, students would gain satisfaction from the grade (r = .613, $\alpha = .000$), getting help from colleagues (r = .667, $\alpha = .000$), getting the exam questions (r = .653, $\alpha = .000$), and submitting a finished paper (r = .633, $\alpha = .000$). Maeda found that parents' behaviors toward their child's cheating, vary from complete unacceptance to active involvement and support. A study by Backman in 2019 suggested another possible reason for the use of dishonest methods, which states that parents' attitudes are putting their children under pressure to achieve good or higher than average grades (Backman, 2019).

It is also found that if monitoring and proctoring methods are introduced, it will not bother the students about the dishonest methods used, with 52.8% of those who completed the questionnaire saying so.

CONCLUSION

As a major conclusion, it can be inferred that despite the dishonest methods used by the students, it generally does not lead to their desired assessment and outcome. This is probably due to the system of conducting examinations at the NSA "Vassil Levski", as well as the well-formulated questions by the lecturers, which do not assume finding the answer on the internet, in a textbook, or from colleagues, but require deeper reflection and analysis.

The use of more components in the formation of a student's final grade, such as current grades on assignments or tests, ensures a more realistic final grade in the respective subject.

The use of a plagiarism detection system among students will put an end to the vicious practice of submitting others' work. This would do well to be backed up with more serious rules and penalties when violations are detected.

Teachers, for their part, could also pay more attention to the issue and have conversations with their students about the use of dishonest practices and the possible punishments and consequences for those who offend.

Creating an environment of trust between lecturer and students by maintaining conversations, discussions, and debating viewpoints would help build a stronger and more meaningful relationship between the lecturer and the group so that students do not turn to dishonest methods.

Enabling proctoring and ensuring greater reliability in the delivery of the online exam will ensure that students take the exam fairly, although the majority of students surveyed felt that it would not stop them.

REFERENCES

Amzalag, M., Shapira, N. & Dolev, N. (2022). Two Sides of the Coin: Lack of Academic Integrity in Exams During the Corona Pandemic, Students' and Lecturers' Perceptions. *J Acad Ethics* 20, 243–263 https://doi.org/10.1007/s10805-021-09413-5

Anderman, E. & Won, S. (2017). Academic Cheating in Disliked Classes, *Ethics & Behavior*, DOI: 10.1080/10508422.2017.1373648

Backman, J. (2019). *Student's Experiences of Cheating in the Online Exam Environment*. Thesis. Retrieved on 22 Aug 2022 from https://www.theseus.fi/handle/10024/167963

Barbaranelli, C., Farnese, M. L., Tramontano, C., Fida, R., Ghezzi, V., Paciello, M., & Long, P. (2018). Machiavellian ways to academic cheating: A mediational and interactional model. *Frontiers in Psychology*, 9, 695.

Bashir, H., & Bala, R. (2018). Development and Validation of Academic Dishonesty Scale (ADS): Presenting a Multidimensional Scale. *International Journal of Instruction*, 11(2), 57-74. https://doi.org/10.12973/iji.2018.1125a

Hensley, L.C., Kirkpatrick, K.M. & Burgoon, J.M. (2013). Relation of gender, course enrollment, and grades to distinct forms of academic dishonesty. *Teaching in Higher Education*, 18(8), 895-907.

Maeda, M. (2019). Exam cheating among Cambodian students: when, how, and why it happens. *Compare: A Journal of Comparative and International Education*, 1–19. https:// doi. org/ 10. 1080/ 03057925. 2019. 16133 44

Miladinov, O., Kuleva, M., Konchev, M. (2022). Success Rate of the Students of National Sports Academy "Vassil Levski" in the Conditions of the Covid-19 Pandemic. *Strategies for policy in science and education*, Volume 30, Number 4, pp.384-396.

Noorbehbahani, F., Mohammadi, A., & Aminazadeh, M. (2022, March 7). A systematic review of research on cheating in online exams from 2010 to 2021 - education and Information Technologies. SpringerLink. Retrieved August 25, 2022, from https://link.springer.com/article/10.1007/s10639-022-10927-7

Paulhus, D.L., Williams, K.M., & Nathanson, C. (2004). *The Self-Report Cheating Scale*. Unpublished instrument, University of British Columbia.

Peytcheva-Forsyth, R., Aleksieva, L., & Yovkova, B. (2018). The impact of technology on cheating and plagiarism in the assessment – The teachers' and students' perspectives. In *AIP conference proceedings.* Vol. 2048, No. 1, p. 020037. AIP Publishing LLC.

Williams, K.M., Nathanson, C., & Paulhus, D.L. (2010). Identifying and profiling scholastic cheaters: Their personality, cognitive ability, and motivation. *Journal of Experimental Psychology: Applied*, 16, pp. 293-307.

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SPORTS PSYCHOLOGY

EMOTIONS, FEELINGS, AND EXPERIENCES IN A MULTICULTURAL CLASSROOM

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ABSTRACT
The Bulgarian educational system is multicultural – in terms of ethnicity, religion, and mother language. The common ethnic groups in the country are Roma, who are the most heterogeneous minority community, Bulgarian Turks, Pomaks, Jews, Vlachs, Armenians, and others. Roma students often have learning difficulties with various etiologies. In these populations, some students do not speak or have a poor command of the Bulgarian language, both in writing and sometimes in spoken language. However, these children and young people need to be educated. Roma students and their parents need active communication and cooperation in this regard. The report presents the results of a study of the emotions and feelings experienced by teachers when working with Roma students and non-Roma students, as well as the emotions and feelings experienced by teachers in communication with the parents of these two groups of students. The research methodology contains eleven concepts characterizing different emotions and feelings and a five-point Likert-type scale measuring their degree of expression. The study was conducted on a sample of 193 teachers. The research results show that teachers often experience stress, fatigue, helplessness, and nervousness when working with Roma students. Joy, serenity, and enthusiasm are too low. When communicating with the parents of Roma students, the emotions experienced are identical. The work of the same teachers with non-Roma students is accompanied by positive emotions and experiences – joy, enthusiasm, vigilance, and calm. Negative emotions and experiences are of low expression. Teachers feel the same emotions and experiences, but in a different order, during their communication with parents of non-Roma students.

Keywords: *Roma pupils, teachers, inclusive education*

INTRODUCTION

The Bulgarian educational system is multicultural - based on ethnicity, religion, and mother tongue. The prevalent ethnic groups in the country are Roma, who are the most heterogeneous minority community, Bulgarian Turks, Pomaks, Jews, Vlachs, Armenians, etc. (Vladova, 2018). Often students of Roma ethnicity recorded difficulties in learning, which have different etiologies. In these populations, some students do not speak or have poor knowledge of the Bulgarian language, not only in writing but sometimes in speaking. However, these children and young people should be educated – as citizens of our country, they have the right to free education and are legally obliged to be educated. In this regard, teachers' active communication and cooperation with Roma students and their parents is necessary. This sometimes creates problems for both parties during the educational process. Issues of different nature are registered. As Yosif Nunev summarizes, the work of pedagogical specialists with Roma children is a real challenge for the development of democratic processes in Bulgaria. Teachers are often under tremendous pressure and stress. They do not receive public recognition for their work. They endure ridicule from society and parents of Roma origin, who perceive them as "representatives of state power". They have a negative attitude towards them, including cases of self-harm. Due to the unattractive working conditions and the reasons listed above, there is often a high teacher turnover in schools with predominantly Roma students (segregated or secondarily segregated schools and classes) (Nunev, 2006). Daily, they face specific difficulties and higher challenges in carrying out their activities: reluctance to attend school voluntarily; lack of parental support and cooperation; difficult communication with parents; poor Bulgarian language proficiency, especially in reading and writing, which is a severe barrier to communication and academic progress; lack of skills and habits for learning activities; weak interest and motivation for learning; a limited repertoire of social skills and difficulty adapting to the school environment; manifestations of aggression towards classmates and teachers; manifestations of mistrust; early school leaving - early marriage and employment; low socio-economic status of families and the resulting problems – poverty, unemployment; migration and emigration at home and abroad; feelings of impunity and arrogant behavior, etc. Daily "encounters" with these problems require greater effort and are additional sources of stress in teachers' pedagogical activity. There are also manifestations of *burnout* (Vladova & Tosheva, 2020). The peculiarities of pedagogical activity in the multicultural classroom are also related to

the expression of different emotions and emotional experiences on the part of all participants in the educational work. In psychology, there is no single opinion on the exact number of emotions. Some authors assume that people communicate with each other with six primary internal emotional states – happiness, surprise, fear, disgust, anger, and sadness (Rachael et al., 2012). These basic emotions, which are universal, are internal states with an external expression of certain stereotypical behaviors, instincts, or survival mechanisms, and according to Gu et al. (2019), the primary emotions are four – happiness, sadness, fear, and anger. They are variously associated with reward, punishment, and stress and are particularly important to human health (Gu et al., 201). According to several authors, emotional communication consists of four categories/elements: fear, anger, joy, and sadness (Jack et al., 2014; Gu et al., 2015; Wang & Pereira, 2016). These four emotions are essential from a biological and psychological point of view (Wilson-Mendenhall et al., 2013). According to other authors, the basic emotions are eight - anger, fear, sadness, disgust, surprise, anticipation, trust, and joy (Robert Plutchik), but according to Ekman, there are seven – fear, anger, happiness, sadness, contempt, disgust, and surprise. Emotions can also be associated with certain feelings: pleasant-unpleasant, tension-relaxation, and excitement-relaxation (Gu et al., 2019).

Aim and objectives of the study

The purpose of the study is to identify the emotions and feelings teachers experience when working with students of Roma and non-Roma origin, as well as the emotions and feelings they experience when working with parents of these two groups of students. The task of the study is also to identify individual differences in emotions in relation to the professional-demographic characteristics of the teachers studied.

METHODS

To implement the research, a methodology was developed, which contains eleven concepts characterizing different emotions and feelings and a five-point Likert-type scale to measure their degree of expression. Statistical processing of the empirical data obtained includes frequency, variance, comparative, and dispersion analysis.

The survey results were processed using a validated statistical procedure using the IBM SPSS 25.0.

Questionnaire

A questionnaire was developed for the study with multiple indicators and characteristics that describe the professional-demographic profile of the teachers covered in the survey. In addition to the main factors such as age, gender, teaching experience, those reflecting the educational level of the teachers, the educational level in which they teach, the subjects taught, the relative proportion of Roma students in the classes, the region of the school, etc. are also included. Eleven concepts characterizing different emotions and feelings and a five-grade Likert-type scale for measuring their degree of expression about communication with students of Roma origin, students of non-Roma origin, parents of Roma origin, and parents of students of non-Roma origin are presented in tabular form.

Participants

The study was implemented on a sample of 193 teachers with a mean age of 46.6 years (Min=22, Max=64; SD=10.57). They work in vocational and secondary schools in 5 cities, primary schools, and one elementary school in 6 villages. The schools are from the districts of Sofia, Pazardzhik, and Blagoevgrad, and they educate students from Roma backgrounds. The occupational and demographic characteristics of the subjects are presented in Table 1.

Table 1. *Distribution of surveyed persons by occupational demographic indicators*

Indicator	Groups	Number (n)	Rate (%)
Gender n=193	Women	149	77.2
	Men	44	22.8
Age n=193	< 30 years	21	10.9%
	31 - 40 years	19	9.8%
	41 - 50 years	58	30.1%
	> 50 years	63	32.6%
	Unanswered	32	16.6%
Pedagogical experience n=193	< 5 years	41	21.2%
	6 – 15 years	27	14%
	> 15 years	110	57%
	Unanswered	15	7.8%
Location n=193	Town	100	51.8%
	Village	93	48.2%
Relative share of Roma pupils in classes n=171	0-25%	21	12.3%
	26-50%	37	21.6%
	51-75%	54	31.6%
	76-100%	59	34.5%

The relative share of women is almost 4/5 compared to men - evidence of the feminization of the teaching profession in the country. The average length of teaching experience in the school where teachers currently work (n=177) is 14.3 years (Min=1; Max=37; SD=11.70). They teach (n=173) an average of 52 students (Min=12; Max=180; SD=37.47) in one or more classes/grades, including school level and subject, and the average number of Roma students they work with (n=169) is 32 (Min=1; Max=132; SD=27.81). For the purpose of analysis, teachers were grouped into three groups in terms of subjects taught - PE, humanities, and science and mathematics. They are divided into five groups according to the educational level they teach: Primary school, Middle school, High school, Primary and Middle school, and Middle and High school.

RESULTS AND DISCUSSION

The results of the study show that in working with Roma students, teachers offer a high degree of vigilance (M=3.46; SD=1.34) and most often experience stress (M=3.00; SD=1.42), fatigue (M=2.90; SD=1.32), helplessness (M=2.83; SD=1.37) and nervousness (M=2.70; SD=1.37). Joy, calmness, and elation had low values (Table 2). The emotions and feelings were similar when the teachers communicated with said students' parents (Table 3).

Table 2. *Mean values of emotions and feelings when working with Roma and non-Roma students*

	Roma pupils (α =.680)		**non-Roma pupils (α =.771)**	
	M	**SD**	**M**	**SD**
stress	**3.00**	1.42	2.30	1.16
fatigue	2.90	1.32	2.55	1.09
helplessness	2.83	1.37	1.80	1.05
nervousness	2.70	1.37	2.16	1.05
calm	2.40	1.20	2.81	1.27
fear	2.17	1.21	1.51	.84
vigilance	**3.46**	1.34	3.19	1.32
elation	2.22	1.21	**3.41**	1.17
joy	2.18	1.27	**3.48**	1.17
antipathy	1.81	.97	1.41	.87
sympathy	2.62	1.17	**3.68**	1.16

Teachers' work with non-Roma students is accompanied by positive emotions and experiences - sympathy, joy, excitement, alertness, and calmness. Negative emotions, feelings, and experiences are low in intensity (Table 2). The same emotions and feelings are also experienced when communicating with parents of non-Roma students; however, in different rank order (Table 3).

Table 3. *Mean values of emotions and feelings when working with parents of Roma and non-Roma students*

	Roma parents (α=.734)		Non-Roma parents (α =.765)	
	M	**SD**	**M**	**SD**
stress	**3.00**	1.45	2.24	1.21
fatigue	2.90	1.42	2.18	1.21
helplessness	2.83	1.48	1.91	1.15
nervousness	2.70	1.40	2.07	1.15
calm	2.40	1.25	2.91	1.36
fear	2.17	1.38	1.53	0.90
vigilance	**3.46**	1.31	2.87	1.24
elation	2.22	1.17	2.89	1.18
joy	2.18	1.16	2.95	1.13
antipathy	1.81	1.10	1.41	0.80
sympathy	2.62	1.18	**3.32**	1.16

The comparative analysis of the emotions experienced when working with Roma students on the factor "gender of the teacher" found a significant difference only in terms of alertness (U=2115.500, p=.009). Female teachers were characterized by more pronounced vigilance (M=3.85) compared to male teachers (M=3.31). When working with non-Roma students, a significant difference was observed in terms of antipathy (U=2106.500, p=.025), and these manifestations for both genders were very low, with males having higher values (M=1.68). For women, the mean value was M=1.32. In both the work with Roma and non-Roma parents, there were no statistically significant differences concerning the gender of the teachers. There were also no statistically significant differences in the feelings and emotions experienced by teachers about the relative proportion of Roma pupils in individual classes.

The educational level or age of Roma students appears to be key to teachers' negative experiences. The comparative analysis (Kruskal-Wallis test) on the factor "educational level" revealed significant differences in stress (χ^2=14.64; p=.006), fatigue (χ^2=12.00; p=.017), expressions of nervousness (χ^2=10.60; p=.031) and fear (χ^2=13.40; p=.010). Pairwise comparison (Mann-Whitney test) showed that primary teachers experienced nervousness, fatigue, and fear to the greatest extent (Table 4):

Table 4. *Mean values of the variables fatigue, nervousness, and fear at different educational levels*

	Primary school teachers	Middle school teachers	High school teachers
fatigue	3.72	3.22	3.06
nervousness	2.98	2.35	2.76
fear	2.20	1.50	1.76

The comparative analysis (Kruskal-Wallis test) on the factor "study subject" showed a significant statistical difference in the stress variable (χ^2 = 18.76, p = .027).

Significant differences in the variables nervousness, fatigue, and fear concerning subject and level of education guided the application of bivariate analysis of variance to establish their aggregate influence. The factor "educational level in which teachers teach" has five levels, and for the factor "subject of study", the eleven subjects included in the study are grouped into three – physical education and sports, humanities and science, and mathematics – three levels of the factor. The re-

sults of the analysis showed that teachers who taught humanities subjects had higher levels of stress in Primary school, Middle school, and High school. For PE and sports teachers, levels of stressful experiences increased as the age of Roma students increased (Figure 1).

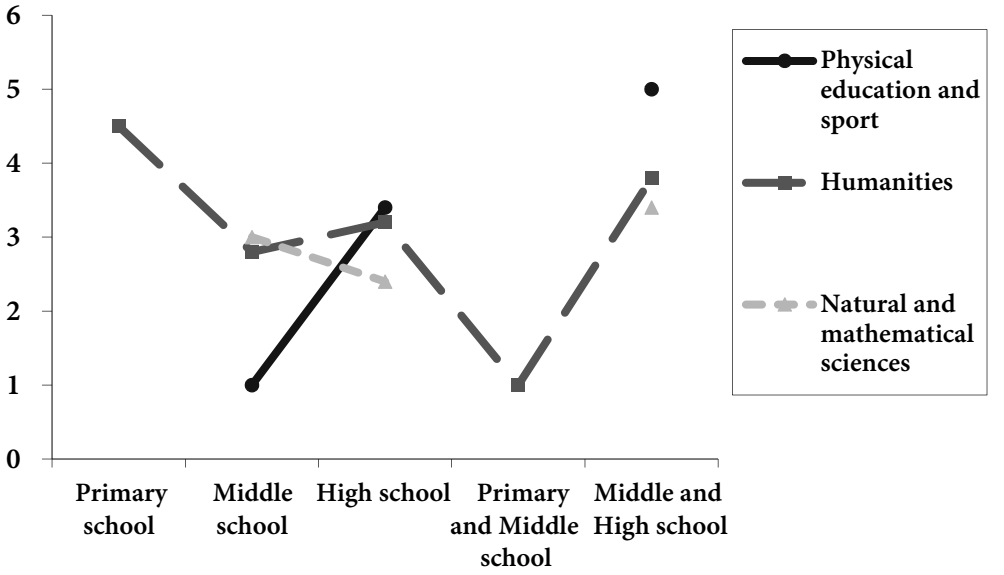

Figure 1. *Results of the analysis of variance regarding stress*

In terms of fatigue, the same trend was observed concerning PE teachers. On the other hand, Primary school teachers and those who teach both middle and High school are characterized by the highest levels of fatigue (Figure 2).

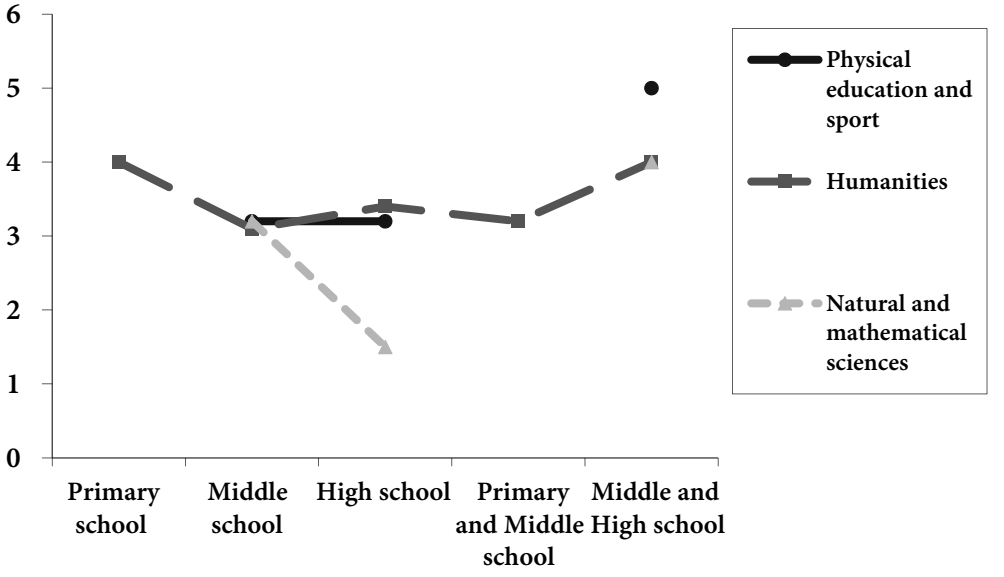

Figure 2. *Results of the analysis of variance regarding fatigue*

The influence of both factors on the state of nervousness is similar. Once again, the variable has the highest values for Primary school teachers and those who teach in both middle and high schools. Nervousness levels were highest among the FHS teachers teaching in middle and high schools (Figure 3).

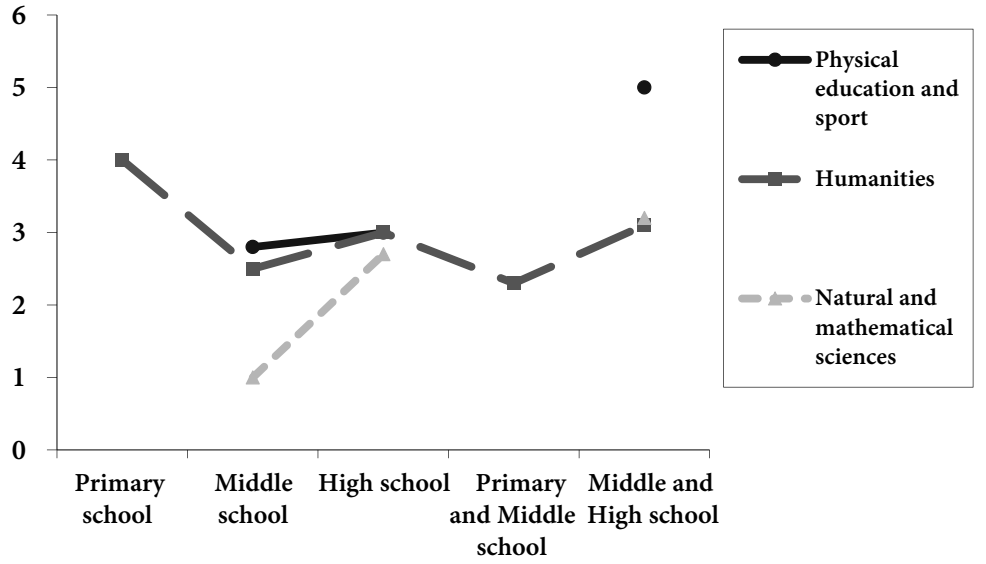

Figure 3. *Results of the analysis of variance regarding the manifestations of nervousness*

Teachers who teach humanities subjects experience fear most often in Middle School. The trends found for physical education teachers persist concerning this variable: the higher grade levels at which they teach are associated with more frequent experiences of fear (Figure 4).

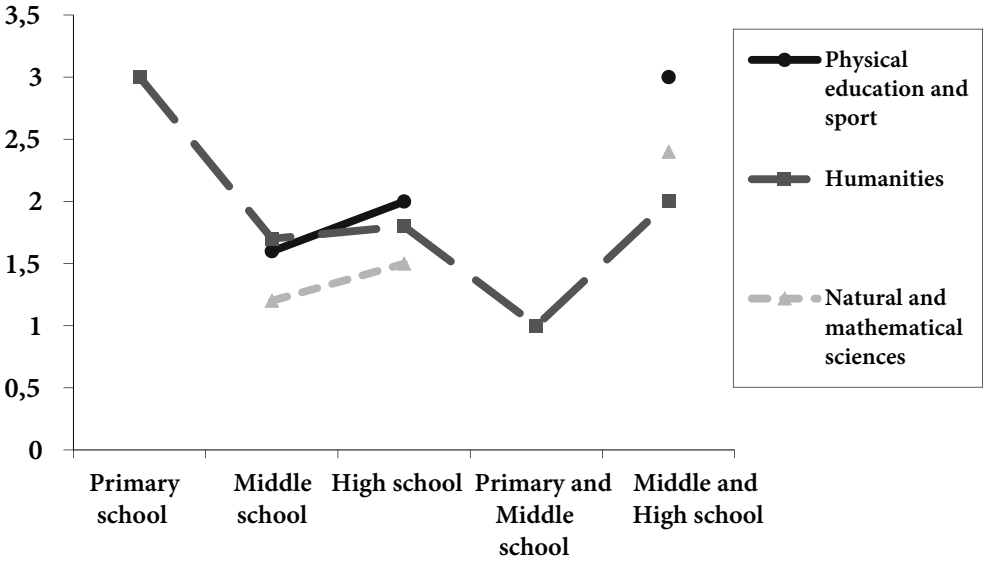

Figure 4. *Results of the analysis of variance regarding the experienced fear when working with Roma students*

This study covers only teachers who teach in multicultural environments with their specificities. Schools and classes differ in the number of Roma students and their ethnocultural specificities. In some schools, the relative share of Roma pupils is not high, others are partially secondary segregated, and there are schools and individual classes in them that are entirely secondary segregated. It turned out that the number and relative share of Roma pupils was not significant when teachers experienced particular emotions and feelings.

As a result of the study, PE teachers who teach Middle and High school students are most likely to experience fear, fatigue, nervousness, and stress. This data is of interest for further research to determine the reasons for these trends.

REFERENCES

Vladova, I. (2018). *Multikulturalizam. Olimpizam. Obrazovanie*. Sofia, NSA PRESS (Владова, И. (2018). *Мултикултурализъм. Олимпизъм. Образование*. Со-

фия, НСА ПРЕС)

Vladova, I., Tosheva, I. (2020). Burnout pri uchiteli, raboteshti s uchenici ot romski etnos., sb. "*Lichnost. Motivacia. Sport*" NSA PRESS, tom 24, 160-177. (Владова, И., Тошева, И. (2020). Бърнаут при учители, работещи с ученици от ромски етнос, сб. „*Личност. Мотивация. Спорт*", НСА ПРЕС; том 24, с. 160-177)

Nunev, Y. (2006). *Romite I procesut na desegregacia v obrazovanieto*. Sofia: Kuna (Нунев, Й. (2006). *Ромите и процесът на десегрегация в образованието*. София: Куна)

Jack, R., Garrod, O., Hui Yu, Caldara, R. and Schyns, Ph. (2012). Facial expressions of emotion are not culturally universal. *PNAS*, vol. 109, no. 19, 7241–7244 https://doi.org/10.1073/pnas.1200155109

Gu, S., Wang, F., Patel, P., Bourgeois, A., and Huang, H. (2019). A Model for Basic Emotions Using Observations of Behavior in Drosophila. *Frontiers in Psychology*, vol.10, Article 781. 10:781. DOI: 10.3389/fpsyg.2019.00781

Wilson-Mendenhall, C., Barrett, L., Barsalou, L. (2013). Neural evidence that human emotions share core affective properties. *Psychological Science*, 24, 947–956. DOI: 10.1177/0956797612464242

Jack, R., Garrod, O., Schyns, P. (2014). Dynamic facial expressions of emotion transmit an evolving hierarchy of signals over time. *Curr. Biol*. 24(2):187-192, DOI: 10.1016/j.cub.2013.11.064

Gu, S., Wang, F., Yuan, T., Guo, B., and Huang, H. (2015). Differentiation of primary emotions through neuromodulators: review of the literature. *Int. J. Neurol. Res*. 1, 43–50. DOI: 10.17554/j.issn.2313-5611.2015.01.19

Wang, F., and Pereira, A. (2016). Neuromodulation, emotional feelings, and affective disorders. *Mens Sana Monogr.* 14, 5–29. DOI: 10.4103/0973-1229. 154533

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BULGARIAN SHORT VERSION OF EMOTIONAL INTELLIGENCE SCALE (EIS-S)

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ABSTRACT
The report presents the results from the validation of a short scale for tracing emotional intelligence. The research was done among 204 people. The survey was based on Davies, Lane, Devonport, and Scott's approach to designing a short scale (2010). With the help of expert assessments of the contents of the items in the original scale of Schutte (1998), Self-Report Emotional Intelligence Test (33 items), they excluded 13 items due to lack of their relations to emotions, 1 item which the experts did not associate with any of the five subscales, and 7 items which were related to more than one subscale. In our research, the items appearing in more than one subscale were subjected to an empirical check for cross loads. Nineteen items were included in the exploratory factor analysis. The results from the analysis led to a 4-factor solution. The subscales related to the regulation of one's own emotions and regulation of others' emotions were united into one factor. The model with four factors and a total number of items – 16 was subjected to confirmatory factor analysis. Two items were excluded due to low factor weights. The model shows good fit indexes and a good validity of the construct (CMIN/DF=1.475; CFI=0.961; SRMR=0.054; RMSEA=0.051; PClose=0.012; NFI=0.89; RFI=0.86). The obtained short version of the test for emotional intelligence possesses good psychometric characteristics and can be used for quick diagnostics.

Keywords: *Emotional Intelligence, Exploratory, Confirmatory Factor Analysis, Reliability, Construct Validity*

INTRODUCTION

The term "emotional intelligence" (EQ) appeared at the end of the 20th century. It provoked great interest, on the one hand, but on the other hand, it raised a lot of arguments. Some perceived it as an unserious variety of intellect; others emphasized the importance of the fact that emotions could be managed. The lack of a shared conceptualization of the construct significantly hampered the development of valid methods for its research.

There are a lot of methods for measuring EI, but most of them are based on unclear theoretical grounds and possess low psychometric characteristics.

Schutte Self-Report Inventory (SSRI) is an approved and most often used method for studying EI (Schutte et al., 1998). The method is based on the model of Salovey and Mayer (1990). It consists of 33 items and four subscales - perception of emotions, managing emotions in the self, social skills or managing others' emotions, and utilizing emotions. This four-factor structure of the method has not been confirmed in a number of studies. Items belonging to a one-factor family have been included in another one. Some items are cross-loading. Different factor structures have been outlined. The problems found in the method provoked the researchers to seek shorter versions with a clear factor structure and good psychometric characteristics.

Several attempts have been made to adapt the method for Bulgarian conditions found in the scientific literature.

Iancheva and Prodanov (2022) made an adaptation but with a minimal sample – 201 football coaches, all of whom were men. They did not check the factor structure of the method. They accepted the factor structure of the original method and analyzed only the inner consistency of the subscales.

Stoyanova (2010) stuck to the approved approaches to adaptation of psychological methods. She got four factors: Sharing emotions and empathy, Motivation for overcoming difficulties and optimism, Recognizing other people's non-verbal expression of emotions, and Recognition of own emotions and self-control.

MATERIALS AND METHODS

This research aimed to check the possibility of creating a short version of a scale for studying emotional

intelligence in Bulgarian conditions. The research was based on the approach to the development of a short scale by Davies, Lane, Devonport, and Scott (2010). Through some expert evaluations of the contents of the items taken from the original scale of Schutte (1998), Self Report Emotional Intelligence Test (33 items), they excluded 13 items due to lack of any relation to emotions, 1 item, which they did not associate with any of the five subscales, and 7 items, which were related to more than one subscale. In this research, the items, presented in more than one subscale, were left for an empirical check for cross-loading. The scale, subject to validation, consisted of 19 items and a 5-point Likert-type scale.

The research was done among 204 people aged from 12 to 65 years – 131 women and 73 men.

Regarding the confirmatory factor analysis, the sample volume met the empirical rule, and it was not less than 50+8k; k – the number of the variables in the data matrix (the number of the items in the test) 50+8*16=178 (Byrne, 2010). The analysis of the empirical data was made with IBM SPSS 25 and IBM SPSS Amos 24.

RESULTS AND ANALYSIS

The check of the empirical matrix for highly digressing values (Mahalanobis distance) showed that 9 of the researched individuals showed values higher than the critical one (54.78; α = .01). They were excluded from the empirical matrix.

We assumed that the initial positions (19 items) correlate with each other to a different degree and could be united in a smaller number of generalized variables – factors. The initial evaluation of the data enabled us to make a factor analysis:

- Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .863
- Bartlett's Test of Sphericity = χ^2=1245.948; df=171; ρ=.001

To establish the inner structure of the test, we performed a factor analysis with the method Maximum likelihood and Promax rotation. We obtained 5 factors. The fifth factor included only one item - № 21 (I have control over my emotions). It was excluded from the empirical matrix. In the next step, there were 4 factors. Item № 26 (When another person tells me about an important event in his or her life, I almost feel as though I experienced this event myself) was with cross-loading, and item № 33 (It is difficult for me to understand why people feel the way they do) was with a low factor weight (r = .33). That is why they were also excluded from the analysis.

The results pointed to a four-factor solution (Table 1). The first factor integrated the items related to the regulation of one's own emotions and the emotions of others. The second factor was determined by the items associated with the use of emotions. The third factor consisted of the items related to the appraisal of one's own emotions. The fourth factor included the items related to the appraisal of the others people's emotions.

Table 1. *Factor structure of the scale*

	Factor			
	1	**2**	**3**	**4**
SH_7	.756			
SH_20	.744			
SH_27	.730			
SH_17	.519			
SH_13		.833		
SH_11		.661		
SH_12		.499		
SH_14		.485		
SH_31		.468		
SH_30		.430		
SH_19			.835	
SH_22			.782	
SH_9			.719	
SH_29				.759
SH_32				.708
SH_18				.493

For the evaluation of the convergent validity, we analyzed the factor weights. In a sample of N=200, the critical value of the factor weights is 0.35 (Gaskin, 2019). There were no items with lower factor weights than this critical value.

To evaluate the discriminant validity, we analyzed the cross-loadings and the matrix with correlations of factors. There were no items with cross-loadings and a difference lower than 0.2. The correlations between the factors were not higher than 0.7 (Table 2).

Table 2. *Factor Correlation Matrix*

Factor	1	2	3	4
1	1.000			
2	.666	1.000		
3	.578	.563	1.000	
4	.417	.398	.379	1.000

The pure factor structure and the high factor weights suggested a high inner consistency of the items, which determined them. For evaluation of the internal consistency, we used a reliability analysis – Cronbach's alpha and Composite Reliability (Raykov, 1997).

The analysis of the results of the factor structure and the inner consistency of the items in the test showed that they were characterized with a definitive criteria trend and a high internal consistency (Table 3).

Table 3. *Indexes for evaluation of the inner consistency of the subscales*

	Subscale 1	Subscale 2	Subscale 3	Subscale 4
Cronbach's alpha	0.77	0.78	0.78	0.77
Composite Reliability	0.79	0.74	0.82	0.70

We used a confirmatory analysis to check the validity of the obtained results. The initial structural model consists of the four factors outlined in the exploratory factor analysis and their indicators (Figure 1).

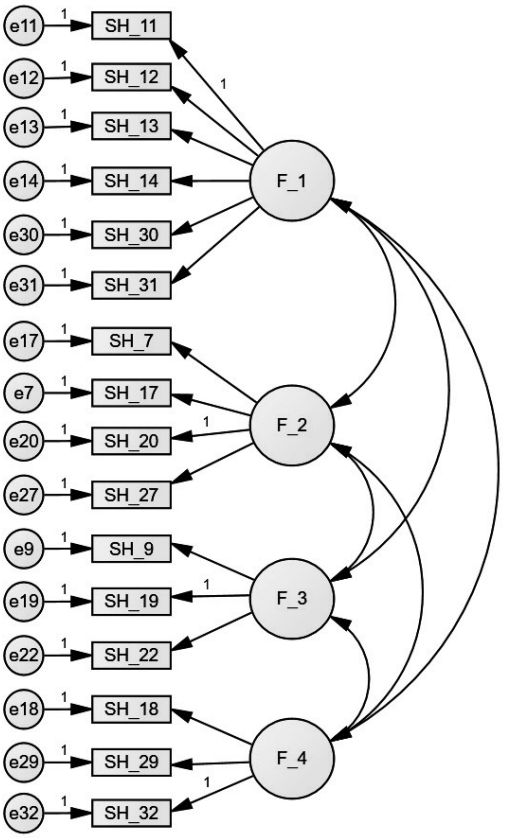

Figure 1. *Initial structure model of Bulgarian Short Version of Emotional Intelligence Scale*

Model parameters:
Number of distinct sample moments: 136
Number of distinct parameters to be estimated: 38
Degrees of freedom (136 - 38): 98

We analyzed the factor weights, the coefficients of multiple correlation, and modification indexes to check the adequacy of the model and its perfection.

The factor weight of indicator № 13 (I arrange events others enjoy) was too small - λ=0.50 and the explained dispersion - 25%. The indicator was excluded from the factor model. The second indicator excluded from the model was item № 7 (When my mood changes, I see new possibilities) - λ=0.52; explained dispersion 27%. The modification indexes do not enable the freedom to evaluate the remaining items belonging to a one-factor family. This means that the contents of the items of the four factors were differentiated and there were no items with similar content. The obtained model comprises four factors and 14 indicators (Figure 2).

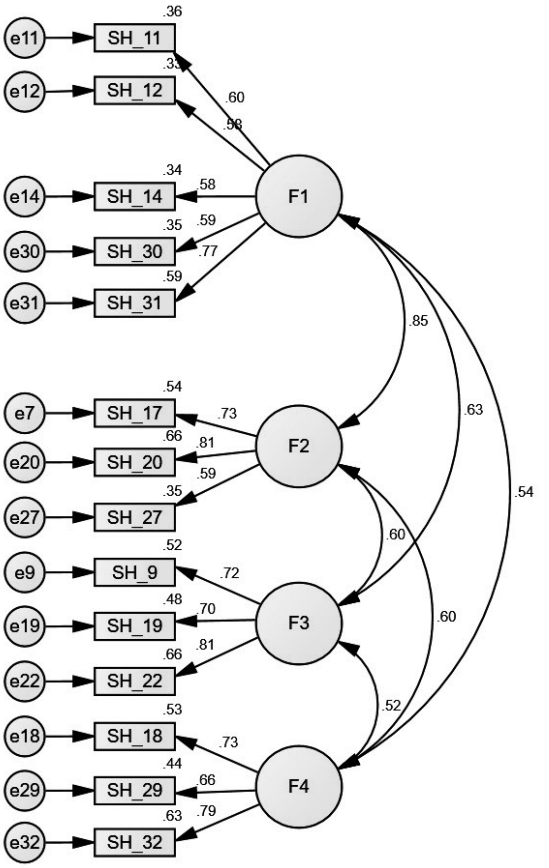

Figure 2. *The final version of the structural model*

The final structure model (Figure 2) indicators are listed below:
First subscale – Regulation of own and others` emotion
11. I like to share my emotions with others.
12. When I experience a positive emotion, I know how to make it last.
14. I seek out activities that make me happy.
30. I help other people feel better when they are down.
31. I use good moods to help myself keep trying in the face of obstacles.
Second subscale – Utilization of emotion
17. When I am in a positive mood, solving problems is easy for me.
20. When I am in a positive mood, I am able to come up with new ideas.
27. When I feel a change in emotions, I tend to come up with new ideas.
Third subscale – Appraisal of own emotion
9. I am aware of my emotions as I experience them.
19. I know why my emotions change.
22. I easily recognize my emotions as I experience them.
Fourth subscale - Appraisal of others` emotion
18. By looking at their facial expressions, I recognize the emotions people are experiencing.
29. I know what other people are feeling just by looking at them.
32. I can tell how people are feeling by listening to the tone of their voice.

Model fit *(characteristics of the model)*
The indexes for adequacy of the structural model enabled its confirmation - CMIN/DF=1.475; CFI=0.961; SRMR=0.054; RMSEA=0.051; PClose=0.012. If we use the indexes NFI=0.89 (Bentler-Bonett normed fit index - Delta1) and RFI=0.86 (Bollen's relative fit index - rho1), we can accept that the analyzed structural model is 89% on the way from an independence model to a saturated model, whose value is 1.

Construct Validity
Justifying the validity and reliability of a measuring model is compulsory in confirmatory factor analysis. Validity is determined as the degree of accuracy of the measurements. One of the primary purposes of the confirmatory factor analysis is to evaluate the validity of the construct. Construct validity is the degree to which the totality of measured indicators actually reflects the theoretical latent construct which these indicators are meant to measure (Sharif, 2013, 2015; Hair et al, 2014).

To assess the construct validity, we used the criteria:
- Composite Reliability (CR);
- Average Variance Extracted (AVE);
- Maximum Shared Squared Variance (MSV);
- Average Shared Square Variance (ASV).

We used the created by Gaskin and Lim Master validity tool – AMOS Plugin (2016).

The obtained values of the criteria and the correlations between them enabled us to confirm the construct validity of the model (Table 4). The values of CR were greater than 0.7, which means that the construct validity was achieved. But, regarding the convergent and discriminant validity of the factors F_1 and F_2, the empirical rules were not obeyed - AVE was lower than MSV and the square root of AVE was smaller than the correlations with the other factors. The indicators of these factors correlated more strongly with the indicators of the other factors than with each other. They were better explained with some other indicators than their own ones. We assume that the reason for the low discriminant validity of the two factors was the higher correlation between them (Table 5).

Table 4. *Indicators of construct validity*

	CR	**AVE**	**MSV**	**MaxR(H)**	**F_4**	**F_1**	**F_2**	**F_3**
F_4	0.773	0.532	0.365	0.782	0.730			
F_1	0.763	**0.395**	**0.729**	0.781	0.536	**0.629**		
F_2	0.759	**0.516**	**0.729**	0.784	0.604	0.854	**0.718**	
F_3	0.787	0.554	0.397	0.797	0.517	0.630	0.597	0.744

Table 5. *Correlations between factors*

			Estimate
F1	<-->	F2	.854
F2	<-->	F3	.597
F4	<-->	F3	.517
F1	<-->	F3	.630
F1	<-->	F4	.536
F4	<-->	F2	.604

The high correlations between the four factors showed a single-factor decision. To check this, we used Harman's single-factor test. With this approach, we can determine whether the indicators (items) variations could be explained with a common factor. If the explained dispersion of the factor is bigger than the explained dispersion with n – number of factors, then the variations of the indicators are better explained with one factor. This approach can be realized in SPSS without a factor rotation.

The results from the analysis showed that the unlimited, as regards factors, option explained a bigger part of the dispersions of the variables (48.28%) (Table 6). The researched variables had their own factor structure and were explained better by their own factors.

Table 6. *A single-factor and a four-factor model*

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
4	1.371	9.792	58.564	.915	6.532	48.280
1	5.423	38.738	38.738	4.782	34.158	34.158

DISCUSSION

The obtained short version of the Self Report Emotional Intelligence Test consists of 14 items and has a four-factor structure: Regulation of own and others' emotion; Utilization of emotion; Appraisal of own emotion; Appraisal of others` emotion.

The results from the research showed very good reliability of the Bulgarian Short Version of Emotional Intelligence Scale (EIS-S), and the smaller number of items, included in the method, makes it a convenient instrument for a quick assessment of emotional intelligence in various scientific surveys.

REFERENCES

Byrne, B. (2010). *Structural Equation Modeling with AMOS. Basic Concepts, Applications, and programming.* Second edition. Taylor and Francis Group, LLC., 2010

Davies, K.A., Lane, A.M., Devonport, T.J., & Scott, J.A. (2010). Validity and Reliability of a Brief Emotional Intelligence Scale (BEIS-10). *Journal of Individual Differences, 31*, 198-208.

Gaskin, J. & Lim, J. (2016). „Model Fit Measures", AMOS Plugin. Gaskination's StatWiki

Gaskin, J. (2019). Confirmatory Factor Analysis. http://statwiki.kolobkreations. com/index.php?title=Confirmatory_Factor_Analysis

Hair, J., Black, W., Babin, B., Anderson, R. (2014). *Multivariate Data Analysis.* Seventh Edition. Pearson Education Limited., Upper Saddle River.

Iancheva, T., Prodanov, G. (2022). Adaptation of the Schutte Self-report Emotional Intelligence Test (Shutte et al., 1998). *Annual of National Sports Academy "Vassil Levski",* Vol. 1, NSA Press, Sofia, p.129-137.

Raykov, T. (1997). Estimation of composite reliability for congeneric measures. *Applied Psychological Measurement*, 21(2), pp. 173-184.

Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition and Personality*, 9, 185–211.

Schutte, N. S., Malouff, J. M., Hall, L. E., Haggerty, D. J., Cooper, J. T., Golden, C. J., & Dornheim, L. (1998). Development and validation of a measure of emotional intelligence. *Personality and Individual Differences*, 25(2), 167–177.

Stoyanova, S. (2010). Validation of a test measuring emotional intelligence. *Bulgarian Journal of Psychology*, (1-4), 791-804.

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INFLUENCE OF PERSONAL CHARACTERISTICS ON MENTAL SKILLS OF TAEKWONDO ATHLETES

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ABSTRACT
Our research is based on the need for more in-depth studies of the relationships and the impact of personal characteristics and mental skills on the successful performance of athletes.
The present study aims to examine the connections and interrelations among personality traits of Big-Five factor markers, International Personality Item Pool - IPIP, (Goldberg, 2001): extraversion, conscientiousness, agreeableness, emotional stability, and openness to experience on mental skills related to successful performance in sport (Thomas, Murphy & Hardy, 1999). The research was done among 28 Bulgarian taekwondo athletes (WTF & ITF; 12-46 years old), divided into groups according to their age, gender, and sports qualification. There are significant differences depending on gender, age, and qualification (medalists and non-medalists). Analysis showed statistically significant correlations between extraversion and goal setting (r=.374; p<.05), emotional control (r=.458; p<.01); visualization (r=.441; p<.05), activation (r=.375; p<.05) and self-talk (r=.406; p<.05) in competition; conscientiousness and negative thinking (r=-.487; p<.01), goal setting (r=.418; p<.05), automaticity (r=.391; p<.05) in practice; openness to experience and goal setting (r=.466; p<.05), self-talk (r=.482; p<.01) in competition and goal setting (r=.382; p<.05) in practice; emotional stability and emotional control (r=.657; p<.01) and relaxation (r=.504; p<.01), negative thinking (r=-.546; p<.01) in competition, emotional control (r=.645; p<.01), attention (r=.464; p<.05) in practice.
The results of the study enrich the knowledge of the mental preparation of taekwondo athletes. Still, some limitations are related to the relatively small number of researched individuals.

Keywords: *Personal factors, Mental skills, Psychological preparation, Taekwondo, TOPS*

INTRODUCTION

The relationship between personality traits and successful athletes are the subject of interest of many Bulgarian and international sports psychologists (Iancheva, T., 2004; Zhelyazkova–Koynova & Savcheva, 2005; Domuschieva-Rogleva, Yancheva, M. & Varneva, 2014; Lyubomirova, Fenerova & Georgiev, 2008; Li et. al., 2020; Król-Zielińska, Ciekot, Zieliński, & Kusy, 2015).

In order to identify whether personality has any meaningful short-term effects, researchers have begun to explore how personality dimensions relate to behaviors associated with success in sport. The five-factor model of personality could be used to predict the player's performance in sports (Piedmont, Hill & Blanco, 1999).

Some psychological techniques-skills are much more often included in athletes' preparation. Lots of researchers have proven that they are basic and crucial for athletes' performance (Savcheva, 2011). The development of mental skills such as positive imagery, mobilization strategies, focusing, relaxation, and other kinds of cognitive or emotional preparation aims to achieve better performance of an activity (Driskell, Cooper & Moran, 1994). Savcheva defined mental skills as skills for self-regulation which unite self-regulation of the passing mental processes and the manifestation of mental qualities helping a person to achieve a high level of sports realization (2011).

The abilities connected with regulating arousal, processing information, and managing emotions are crucial determinants of the performance of competitive athletes (Thomas et al., 1999). Williams and Krane (2001) suggested that mental strategies were the top components of peak performance. According to Lim (2007) the self-regulation of combat athletes such as boxing, judo, and taekwondo, the winners are ranked significantly higher in the areas of self-confidence and positive thinking. In other research Nam et. al. (2022) outlined six major sport psychological skills demonstrated by Taekwondo athletes in training and competition situations, including goal setting, confidence, imagery, self-talk, fighting spirit, and concentration. There have also been numerous studies on Taekwondo athletes' psychological skills (Eom, Jang & Yang, 2013; Ba-

gherpour et.al., 2012; Yang, Shin, & Kim, 2015; Zetou et. al., 2014; Lim & O'Sullivan, 2016), revealing that relaxation, self-talk, and imagery are especially closely related to the athletic performance.

This study aimed to examine the connections and interrelations among personality traits: extraversion, conscientiousness, agreeableness, emotional stability, and openness to experience mental skills related to successful performance in sport.

Tasks of the research:

- to determine the levels of psychological traits: extroversion, agreeableness, conscientiousness, neuroticism, and openness to experience (intellect/imagery) and mental skills in Bulgarian taekwondo athletes;
- to establish whether there is a difference between the research variables of
- the examined factors: gender, age, and sports qualification;
- to establish the existence of different relations and interdependencies between the studied variables.

The research was done among 28 Bulgarian taekwondo athletes (WTF & ITF; 12-46 years old), divided into groups according to their age, gender, and sports qualification (Table 1).

Table 1. *Researched individuals differentiated into groups*

		N
Gender	Women	14
	Men	14
Age	12 - 21	16
	22 – 46	12
Sports qualification	Medalists	18
	Non-medalists	10

METHOD

For the aim of the study, the following psychological questionnaires were used:

1. *Test of Performance Strategies (TOPS) - Thomas, Murphy & Hardy (1999) – Bulgarian adaptation by Zhelyazkova-Koinova, Savcheva, Yordanov (2010). It* measures a comprehensive range of psychological skills and techniques and their strategic use by athletes in competition and practice. Subscales were developed targeting eight of the most salient psychological skills and processes thought to underlie successful athletic performance. These skills are goal setting, relaxation, activation, imagery, self-talk, attentional control, emotional control, and automaticity.

2. *The Big Five personality test (50 items) (Goldberg, 1992), Bulgarian adaptation by Alexandrova-Karamanova (2016).* The dimensions of the big five model include extroversion, agreeableness, conscientiousness, neuroticism, and openness to experience (intellect/imagery).

The results of the study were processed with the statistical program SPSS 23. We applied comparative analysis, stepwise regression analysis with varimax rotation, and correlation analysis (Spearman criterion).

The parents of under-age athletes and all adult participants were informed about the purpose of the study and the basis for participating in it. Athletes were also assured that their answers and information would be kept confidential. Finally, informed consent was obtained from them to participate in the research.

The data were collected with anonymous, self-reported electronic questionnaires at the beginning of April 2021.

RESULTS

The results from the *comparative analysis* showed statistically significant differences between four of researched variables differentiated: by sex (Mann-Whitney) in relation to the following indicators: emotional stability (U=-2.97; p=.003; r=0.56), psychological skills related with competition: relaxation (U=-2.44; p=.015; r=0.46) as well with psychological skills related with practice: emotional control (U=-2.04; p=.041; r=0.39) and activation (U=-2.12; p=.034; r=0.40). The effect size of the first three variables was bigger than the typical one; for the variable emotional stability, it

was much bigger than the typical one, allowing us to accept the obtained results as reliable.

We found statistically significant differences by age (Kruskal-Wallis). The participants were differentiated into two groups (12-21 years and 22-46 years old). There were statistically significant differences in relation to negative thinking during competition (U=-2.65; p=.008; r=0.50) and personal trait – emotional stability (U=-2.65; p=.008; r=0.50).
The effect size of the variables mentioned above was big or bigger than the typical one, giving us firm grounds to accept the results.

Last, the respondents were divided into two groups (Mann-Whitney) by qualification - medalists (n=18) and non-medalists (n=10). There were discovered statistically significant differences in following variables: visualization (U=-2.41; p=.016; r=0.46), self-talk ((U=-2.72; p=.007; r=0.51), goal-setting (U=-2.65; p=.008; r=0.50), activation (U=-2.63; p=.009; r=0.50) during competitions and self-talk (U=-2.41; p=.016; r=0.47) during practice. There was also a difference in extroversion (U=-2.31; p=.021; r=0.44). The effect size was within the typical values or bigger than the typical, which confirms the established statistical differences.

Correlation analysis (Fig.1) showed statistically significant correlations between psychological skills (performance strategies) used by athletes in competitions and practices and personal traits as follows:

- *Mental skills in competitions:* negative thinking and *conscientiousness* (r= -.487; *p<.01*) and with *emotional stability* (r= -.546; *p<.01*); relaxation and extraversion (r=.346; *p<.01*), and with emotional stability (r=.504; *p<.01*); *self*-talk and extraversion (r=.406; *p<.05*), and with *openness to experience* (r=.482; *p<.01*); activation and extraversion (r= 0.375; *p<.05*); emotional control and extraversion (r=.458; *p<.01*), and with emotional stability (r=.657; *p<.01*); goal setting and extraversion (r=.374; *p<.05*), and with emotional stability (r=.466; *p<.05*).

- *Mental skills in practices:* goal-settings and *conscientiousness* (r=.418; *p<.05*), and with *openness to experience* (r=.382; *p<.05*); automaticity and *conscientiousness* (r=.391; *p<.05*); emotional control and emotional stability (r=.645; *p<.01*); attention and emotional stability (r=.464; *p<.05*) *(Figure1).*

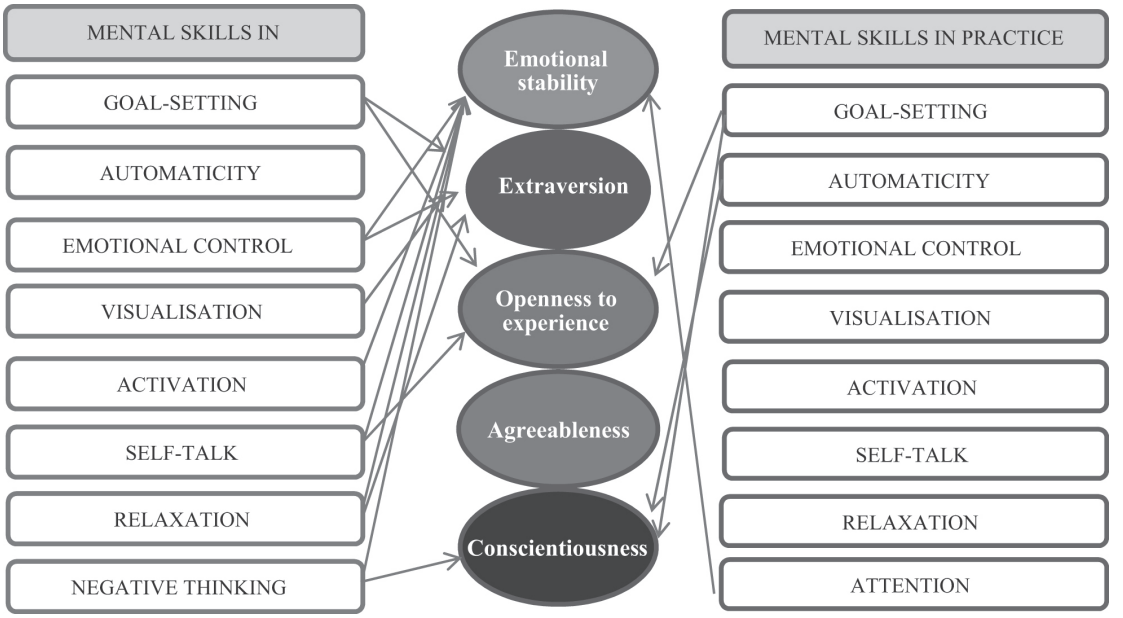

Figure 1. *Correlations between mental skills and personal factors*

In conformity with the aim of the research, a step regression analysis was used. We made several regressional models for the whole group. Each of the mental skills related to successful performance (16 – 8 in competition and 8 in training) was consequently placed as a dependent variable. The personal characteristics took the role of the independent variables: *conscientiousness, extraversion, openness to experience (intellect/or imagery), goodwill, and emotional stability* (Table 2).

Table 2. *Results from the regression analysis*

Independent variable	**Goal-setting (competition)**			***Δ R²***
	β	*t*	*Sig.*	
Openness to experience	.425	2.396	.024	.149
	Emotional control (competition)			***Δ R²***
	β	*t*	*Sig.*	
Emotional stability	.580	4.082	.000	.435
Conscientiousness	.309	2.173	.039	.506
	Relaxation (competition)			***Δ R²***
	β	*t*	*Sig.*	
Emotional stability	.547	3.333	.003	.272
	Negative thinking (competition)			***Δ R²***
	β	*t*	*Sig.*	
Conscientiousness	-.451	-3.046	.005	.313
Emotional stability	-.428	-2.893	.008	.465
	Visualization (competition)			***Δ R²***
	β	*t*	*Sig.*	
Extraversion	-.396	2.198	.037	.124
	Self-talk (competition)			***Δ R²***
	β	*t*	*Sig.*	
Extraversion	.410	2.289	.030	.136
	Goal-setting (practices)			***Δ R²***
	β	*t*	*Sig.*	
Conscientiousness	.429	2.423	.023	.153
	Emotional control (practices)			***Δ R²***
	β	*t*	*Sig.*	
Emotional stability	.636	4.197	.000	.381
	Attention (practices)			***Δ R²***
	β	*t*	*Sig.*	
Emotional stability	.449	2.564	.016	.171

DISCUSSION

According to gender differences, we found that male taekwondo athletes are more likely to use relaxation techniques in competitions, better control their emotions, and are more effective in managing activation in practices than female athletes. Female athletes have less emotional stability (M=2.26; SD=0.83) than male athletes (M=3.33; SD=0.82) in our research.

The same statistical differences along the factor of gender were found by Alexandrova-Karamanova (2016) in the emotional stability scale when she adapted the questionnaire Markers of the Five Big, as well as by other authors (Domushchieva-Rogleva, Yancheva, Varneva, 2014).

The differences that we found, according to the age distribution of the taekwondo competitors, showed that negative thinking during competition is lower among adult athletes (22-46 years old), and they are more emotionally stable than younger athletes (12-21 years old).

Medalists are more skilled in goal setting, visualization, activation, and self-talk during competitions. They have more effective self-talk during their practices than non-medalists and less experienced taekwondo competitors. Medalists are also much more extroverted than other researched taekwondo athletes.

From the regression analysis, we found out that athletes with better emotional stability and a high

level of conscientiousness will better control their own emotions during competitions. Also, if they have better emotional stability (low neuroticism), they will use relaxation techniques often in competitions. Taekwondo athletes with a lower level of neuroticism and a high level of conscientiousness will have lower negative thinking during competitions. According to the psychological trait extraversion, athletes with high extraversion will use fewer visualization techniques during competitions. Also, the high levels of extraversion will lead to more effective use of self-talk during competitions. If the athletes have a high level of conscientiousness, they will use successful goal-setting more often during practices. The lower levels of neuroticism lead to better control of emotions and attention during practices and vice versa.

In conclusion, the personality traits from "The Big Five" indirectly influence the sports performance of the researched taekwondo athletes through the established impact of most mental skills.

The revealed interdependencies between taekwondo competitors' personality traits and mental skills provide essential guidelines for perfecting the training process regarding their mental preparation.

The findings of this study are limited, as they represent one small group of Bulgarian taekwondo athletes.

REFERENCES

Aleksandrova-Karamanova, A. (2016). Markeri na Golemite pet faktora. Mezhdunaroden lichnostov aytem fond – L. Goldberg. Rakovodstvo za ipolzvane balgarskata versia na vaprosnika. Nepublikuvan rakopis.// Александрова-Караманова, А. (2016). Маркери на Големите пет фактора. Международен личностов айтем фонд – Л. Голдбърг. Ръководство за използване българската версия на въпросника. Непубликуван ръкопис.

Domuschieva-Rogleva, G., Yancheva, M. & Varneva, M. (2014). Lichnostni determinanti na nivoto na samokontrol pri sastezateli po sambo. *V: Lichnost, motivatsia, sport.* Tom. 19, NSA PRES, Sofia, str. 21-31. // Домусчиева-Роглева, Г., Янчева, М., Варнева, М. (2014). В*:* Личност*,* мотивация*,* спорт. Том. 19, НСА ПРЕС, София, стр. 21-31. Личностни детерминанти на нивото на самоконтрол при състезатели по самбо.

Driskell, J., Cooper, C., Moran A. (1994). Does mental Practice Enhance Performance?, *Journal of Applied Psychology,* Vol.79, No. 4, 481-492.

Engwerda, I. M., Lidor, R. & Elferink-Gemser, M. T. (2020). Performance characteristics of top-level youth judokas in light- and heavy-weight categories. *International Journal of Sports Science & Coaching,* 15(5–6), 783–792. https://doi.org/10.1177/1747954120945160.

Eom, K-H., Jang, S-Y., & Yang, D-S. (2013). The effect of applied psychological skill training program on business team Taekwondo athletes. J. Coach. Dev. 2013, 15 (3), 57–67. Available online: http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE02263378 (accessed on 10 September 2022).

Goldberg, L. R. (1992). The development of markers for the Big-Five factor structure. *Psychological Assessment, 4*(1), 26-42.

Iancheva, T. (2004). *Lichnost i sastezatelna realizatsia.* NSA PRES, Sofia. // Янчева, Т. (2004). *Личност и състезателна реализация*, НСА ПРЕС, София.

Król-Zielińska, M., Ciekot, M., Zieliński, J. & Kusy, K. (2015). The personality of highly trained athletes given the Big Five model. Antropomotoryka. *Journal of Kinesiology and Exercise Sciences.* 72. 29-34. 10.5604/17310652.1210187.

Li, B., Ding, C., Fan, F., Shi, H., Guo, L., & Yang, F. (2020). Associations Between Psychological Profiles and Performance Success Among Professional Taekwondo Athletes in China: A Multidimensional Scaling Profile Analysis. *Frontiers in Psychology*, 11, 822. https://doi.org/10.3389/fpsyg.2020.00822.

Lim, T., & O'Sullivan, D. M. (2016). Case Study of Mental Skills Training for a Taekwondo Olympian. *Journal of human kinetics*, *50*, 235–245. https://doi.org/10.1515/hukin-2015-0161

Lim, T. (2007). Development of Model and Priority Order of Decisional Factors on Taekwondo Performance. *K J Sport Sci*; 20(1): 58-70.

Lyubomirova, S., Fenerova, D. & Georgiev, M. (2008). Vliyanie na tipologichnite osobenosti varhu predsastezatelnata trevozhnost pri sportisti po tenis. *V: Lichnost, motivatsia, sport.* Kniga 2, Tom. 13, NSA PRES, Sofia, str. 24-32. // Любомирова, С., Фенерова, Д., Георгиев, М. (2008). Влияние на типологичните особености върху предсъстезателната тревожност при спортисти по тенис. В*:* Личност*,* мотивация*,* спорт. Книга 2, Том. 13, НСА ПРЕС, София, стр. 24-32.

Nam, J. H., Kim, E. J., & Cho, E. H. (2022). Sport Psychological Skill Factors and Scale Development for Taekwondo Athletes. *International Journal of Environmental Research and Public Health*, 19(6):3433. https://doi.org/10.3390/ijerph19063433.

Piedmont, R.L., Hill, D.C., & Blanco, S. (1999). Pre-

dicting athletic performance using the five-factormodel of personality. *Personality and Individual Differences, 27*, 769-777.

Savcheva, E. (2011). Vliyanie na mentalnia trening varhu sastezatelnata realizatsia pri fehtovachi, disertatsia, NSA "Vassil Levski". // Савчева, Е. (2011). Влияние на менталния тренинг върху състезателната реализация при фехтовачи, дисертация, НСА „Васил Левски".

Thomas, P., Murphy, S. & Hardy, L. (1999). Test of performance strategies: Development and preliminary validation of a comprehensive measure of athletes' psychological skills, *Journal of Sports Sciences,* 17:9, 697-711, DOI: 10.1080/026404199365560.

Williams, J.M., & Krane, V. (2001) Psychological Characteristics of Peak Performance. *In: Williams, J.M., Ed., Applied Sport Psychology: Personal Growth to Peak Performance*, May Field Publishing Company, Mountain View, 137-144.

Bagherpour, T., Hashim, H.A., Saha, S., & Ghosh, A.K. (2012). Effects of progressive muscle relaxation and internal imagery on competitive state anxiety inventory–2R among Taekwondo athletes. *Int. Proc. Econ. Dev. Res.*, 30, 218–224. Available online: http://www.ipedr.com/vol30/43-ICEMI%202012-M10020.pdf (accessed on 10 September 2022).

Yang, J.E., Shin, J.T., & Kim, J.S. (2015). The Effects of a Psychological Skills Training on Competitive Anxiety, Intrinsic Motivation, Sports Self-Confidence, Performance Strategy and Perceived Performance of High School Taekwondo Players.*Journal of the Korean society for Wellness*, 10(2), 147-160. Available online: http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE06602298
(accessed on 10 September 2022).

Zetou, E., Vernadakis, N., Bebetsos, E., & Liadakis, N. (2014). The effect of self-talk on Tae-kwon-do skills' learning of novice athletes and perceived use of it. *J. Hum. Sport Exerc.,* 9, 124–135. Available online: https://www.redalyc.org/pdf/3010/301031526013.pdf (accessed on 10 September 2022). [CrossRef].

Zhelyazkova-Koinova, Z.& Savcheva, E. (2005). Model na vzaimodeystvieto mezhdu lichnostnite osobenosti, faktorite na sastezatelnata sreda i sastezatelnata realizatsia pri fehtovachi (14-19 g.). *V: Lichnost, motivatsia, sport.* Tom. 10, Sofia, NSA PRES, str. 77-82.// Желязкова-Койнова, Ж., Савчева, Е. (2005). Модел на взаимодействието между личностните особености, факторите на състезателната среда и състезателната реализация при фехтовачи (14-19 г.). В: Личност, мотивация, спорт. Том. 10, НСА ПРЕС, София, стр. 77-82.

Zhelyazkova-Koynova, Z. & Savcheva, E. & Yordanov, V. (2010). Balgarska adaptatsia na testa za izsledvane na strategii za postizhenie (TOPS). *V: Lichnost, motivatsia, sport,* Tom. 15. NSA PRES, str. 66-74. ISBN 978-954-718-279-0.// Желязкова-Койнова, Ж., Савчева, Е, В. Йорданов (2010). Българска адаптация на теста за изследване на стратегии за постижение (TOPS). В: Личност, мотивация, спорт. Том. 15, НСА ПРЕС, София, стр. 66-74. ISBN 978-954-718-279-0.

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ANALYSIS OF THE RELATIONSHIP BETWEEN THE GOAL ORIENTATION AND THE FACTORS HINDERING THE PERFORMANCE OF ELITE ATHLETES

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ABSTRACT
Outstanding athletic performance is unthinkable without strong goal motivation, but at the same time, performance can be affected by a variety of challenges and distractions during an athlete's career. This study aimed to understand the relationship between the type of goal orientation and factors that interfere with sports performance in competition and training processes.
Method: This study involved 43 athletes with successful performance experiences in international competitions. Athletes were in age from 15 to 31 (M=19,3 years). There were 24 (55,8 %) men. The Perception of Success Questionnaire (Roberts et al., 1998) and Sport Interference Checklist (Donohue B. et al., 2007) for athletes' self-assessments were used.
Results: The results of the study indicate the most commonly reported athletes' performance impairments were related to dysfunctional thoughts and stress related to both training and competition situations. The results showed a correlation between performance problems in competitions and task goal orientation. The elite athletes had higher task goal orientation than ego goal orientation, and problems that hindered athletes' sports performance were more common during competitions than in training. There were no gender differences in athletes' perception of issues that interfere with sports performance and no statistically significant differences between gender in athletes' responses about ego and task goal orientation.
Conclusions: The responses of elite athletes showed a correlation between athletes task goal orientation and their high motivation, which determined the low impact of disruptive factors (related to motivation) on athletic performance in competitions.
The results of this study can be used for the development of targeted training programs for psychologists who would like to work in the field of sports psychology in Latvia in the future.

Keywords: *elite athletes, factors interfere with sports performance, EGO goal orientation, Task goal orientation.*

INTRODUCTION

High-performance sports require a lot from the athlete involved. Daily high-intensity long physically hard practicing hours, tactical and technical training, and high emotional load during both preparation and competition periods.

Performance in sports is determined by the athlete's physical, technical, tactical, physiological, and psychological/social characteristics. Scientists in the field of sport psychology work to obtain evidence and satisfy the interest of coaches, athletes, and sport psychologists in the causes and remedies that may lead to a decline in athlete performance that reduces an athlete's effort, motivation, or persistence. In this aspect, it is also important to identify factors that hinder performance.

Since the cognitive perspective in sport psychology began, it has been assumed that variations in motivated behavior are the way how athletes explain and interpret their sports experiences. The assumption that cognition mediates behavior has laid the theoretical foundation for the majority of sport psychology research in the 1980s and 1990s. (Roberts, 1984; Roberts, 1992). A recognized cognitively based approach to the study of motivation today is based on theories of the goal perspective of motivated behavior (Ames, 1984; Ames, 1992; Dweck, Leggett, 1988; Elliott, Dweck, 1988; Nicholls, 1984; Nicholls, 1989; Nicholls, 1992). These theories suggest that in achievement-related contexts, such as sports, there are two main goal perspectives at work that relate to how people define success and evaluate their level of competence. The first goal perspective is based on task involvement. This means that perceptions of high ability and subjective success are based on learning experiences, personal development, and mastery of tasks. The second goal perspective is related to ego involvement. It points

to feelings of personal achievement and high competence underlying success. Subjective success is based on the perception that one has defeated others and/or demonstrated superior abilities.

The achievement goal theory was originally developed to explain educational achievement. This theory was widely applied in the context of sport and exercise research later (Lavallee et.al., 2004). Specifically, in sport psychology, there is a plethora of motivation questionnaires (Clancy et al., 2016). However, one of the two main scales is most often used to assess the motivation of athletes: The Task and Ego Orientation in Sport Questionnaire (TEOSQ) (Duda, Nicholls, 1992); and/or Perception of Success Questionnaire (POSQ) (Roberts, Treasure, Balague, 1998).

POSQ is a measure of achievement goals in sports. It was first formulated using an athletic sample of university students (Roberts et al., 1998). In its development, an initial pool of 48 items was reduced to 26, and this version was found to have strong psychometric properties (Roberts et al., 1995). In search of a more parsimonious and optimal scale, (Roberts et al., 1998) tested a 16-item version, which was then reduced to 12 items equally divided into two scales: a task orientation scale and an ego orientation scale. The correlations between the short form and the long form are 0.98 (task) and 0.97 (ego), reinforcing the efficacy of the 12-item version to measure achievement goals in sports. Researchers found a positive relationship between ego orientation and levels of enjoyment (Biddle et al., 1996). However, much of the remaining research has found either negative relationships or no relationships between ego orientation and enjoyment, intrinsic interest, and satisfaction (Biddle et al., 2003). And most of the previous researchers revealed that women had significantly higher scores in task orientation than men, and men had a significantly higher score in ego orientation (Duda, 1989; Newton, Duda, 1993; Walling, Duda, 1995).

A wide range of challenges that athletes face in specific sports training and competition situations affect their athletic performance and achievements. McCann (1995) believes that as much as 99% of athletic effort occurs in training situations prior to competition, which means that research into training situations can be just as important as research into competitive situations. Moreover, athletes learn requisite skills in training practice that strongly influence outcomes in competition. Weinberg and Williams (1998) suggest athletes who display poor mental performance (i.e., inability to concentrate, negative attitudes, poor work ethic) in training invariably display such behaviors during competition. For this reason, both the competition and training contexts must be considered when assessing problems that interfere with optimal athletic performance. And competition and training situations require different characteristics of athletes, so research tools need to evaluate sports problems in training and competition situations separately.

The initial measuring instruments in sport psychology focused on studying athletes in competition. Sport Interference Checklist (SIC) measures cognitive and behavioral problems that have been identified to interfere with sports performance in both training and competition situations. The SIC consists of 26 problem statement items (i.e., negative thoughts about personal performance, feeling stressed out, problems with my teammates. For each item, participants are asked to report how frequently the stated problem interferes with their sports performance in sports training (The Problems in Sports Training Scale or PSTS) and sports competition (The Problems in Competition Training Scale or PSCS) and also asked to report if they would visit a sport psychologist to assist with the respective problem (Desire for Sport Psychology Scale, or DSPS). Only the PSTS and the PSCS scales were relevant to the present study. The factor structure for both the training and competition scales of the SIC was established by Donohue, Silver et al. (2007) in a sample of 141 student-athletes participating in either NCAA or club sports. PSTS scale has high internal consistency, as evidenced by Cronbach's α of 0.91. PSCS has high internal consistency, as evidenced by Cronbach's α of 0.92 (Donohue et al., 2007).

This study aimed to find:
- the most common factors hindering sports performances in training and competitions,
- the leading types of goal achievements,
- correlations between the type of goal orientation and factors inhibiting athletic performance,
- compare the obtained results between genders.

METHODOLOGY

In this study, The Perception of Success Questionnaire (POSQ) built by Roberts et al., (1998) and the

Sport Interference Checklist (SIC) by Donohue et al., (2007) were used to reveal the relationship between the type of goal orientation and the factors that interfere with sports performance.

Each participant was informed in writing that the study was completely anonymous and voluntary and that participation in it was considered consent to participate.

Mean and standard deviation, count, and relative count were used for the description of data. T-test was used to compare independent groups, Pearson's correlation coefficient was used to describe the association between scales, and Cronbach's α was used to assess scale reliability or internal consistency.

Participants of this investigation are 43 talented athletes. They all perform in 11 different summer individual sports such as tennis, BMX cycling, athletics, canoe, kayaking, rowing, karate, swimming, and some others. They participate in European and World level competitions. Athletes were in age from 15 to 31, M = 19,3 years (SD±3,8). There were 24 (55,8 %) men and 19 women (44,2%).

RESULTS

POSQ includes 12 items on a 5-Point Likert scale that gives two scales, namely, EGO – orientation scale and TASK- orientation scale. Higher points on the EGO orientation scale indicate lower EGO goal orientation, and higher points on the TASK orientation scale indicate lower TASK goal orientation. Both scales showed moderate internal consistency, Cronbach's α values were 0.85 and 0.77 for the EGO orientation and TASK orientation scales, respectively.

SIC consists of 3 scales. The first scale is the «Problems in Sports Training Scale» (PSTS). It consists of 26 items on a 7-Point Likert scale, and they yield 4 subscales. These 4 subscales are «Dysfunctional Thoughts and Stress", «Academic Problems», «Injury Concerns», and «Poor Team Relationships». Cronbach's α for the total scale is the highest at 0.85, all subscales showed lower internal consistency, ranging from 0.53 to 0.61.

The second scale is the «Problems in Sport Competition Scale» (PSCS), again consisting of 26 items on a 7-Point Likert scale, and they yield 6 subscales: «Dysfunctional Thoughts & Stress», «Academic and Adjustment Problems», «Lack of Motivation», «Narcissism», «Injury Concerns» and «Pain Intolerance». Cronbach's α for the total scale was 0,86, but subscales showed significantly lower Cronbach's α values, ranging from 0,18 to 0,77. The lowest Cronbach's α value is for the Narcissism subscale.

The third scale is the «Desire for Sport Psychology Scale» (DSPS). This scale was not relevant to this study and was not further analyzed in detail and discussed.

SIC all scales and subscales were compared between gender. And all total scales and subscales showed no statistically significant differences between women and men (all $p > .05$). These results were similar to those obtained by Donohue et al. (2007) study.

The interest of this study was to find common factors which were hindering sports performances in training and competitions. As results of descriptive analysis showed, the most commonly reported performance impairments were related to dysfunctional thoughts and stress in both training and competition situations. For example, in training situations, «Negative thoughts about personal performance» (item 1) 41% of respondents indicated that their performance is affected «Sometimes » 18.6% «Often», but 7% of respondents admit that it affects their training work «Very often». But during the competition, athletes note that: «Negative thoughts about personal performance» (item 1) were affected by 34.9% of respondents «Sometimes», 16.3% «Often», 7.0% «Very often», but 2.3% of those surveyed athletes «Always».

Descriptive analysis showed that in the subscale «Dysfunctional thoughts and stress» (PSCS1) in the answers given by athletes, the most common factors hindering performance were the following: «Over Concern or worry much about what others think about my performance» (item 8) when 55.8% of athletes mentioned it as a factor to negatively impact performance (18.6% «Sometimes»; 14.0% «Often»; 11.6% «Very often» and 11.6% «Always») and situations connection with «Feeling stressed out» (item 10) when 67.4% of the surveyed athletes experience this factor as a nuisance in competitions (34.9% of athletes «Sometimes», but 20.9% «Very Often»). During the competition, athletes noted that «Nega-

tive thoughts about personal performance" (item 1) «Sometimes» affected 34.9% of respondents, «Often» 16.3%, «Very often» 7.0%, but 2.3% of surveyed athletes «Always». «Difficulties to relax» (item 7) were mentioned by 55.9% of the surveyed athletes as a factor hindering sports performance in competition (23.3% «Sometimes»; 18.6% «Often»; 9.3% «Very often» and 4.7% «Always»)

But more than 50% of athletes answered in the negative to varying degrees about the following situations (it means that this factor did not hinder their performance): 72% were «Distracted (or upset) by people who observe me» (item 4) (distribution of answers were 37,2% «Never»; 27,9% «Very seldom»; 11,6% «Seldom»), 60% of the surveyed athletes responded in the negative were «Difficulty concentrating or maintaining focus to the task at hand» (item5) (18,6% «Never»; 30,2% «Very seldom»; 11,6% «Seldom») and, 58,2 % were «Difficulty thinking positively one negative thoughts have occurred» (item 5) (18,6% «Never»; 14,0% «Very seldom»; 25,6% «Seldom»).

It is also interesting to note that in the subscale «Pain intolerance» (PSCS6) item 22 «Difficulties dealing with physical pain» mentioned in athletes' self-assessment responses «Seldom» in 16,3% of cases, «Very Seldom» 20,9%, «Never» 32,6%. And about «Using prescribed medication to assist in the management of an injury» (item 23) 25,6% of the surveyed athletes reported «Never»; «Very seldom» 30,2% of athletes; «Seldom»14,0% of the surveyed athletes. In general, this factor was indicated as having relatively little influence on sports performance in competitive situations.

In competition situations (subscale «Lack of motivation» (PSCS3)) 88.5% of surveyed athletes were convinced that «Others have commented that I am not motivated in my sports» (item 13) did not interfere with their performance at all or rarely (distribution of answers were 51,2% of athletes answer «Never»; 23,3% «Very seldom»; 14% «Seldom») and similar in two other problem statements «Lack of desire and will to win» (item 13) when 86,1% of all athletes answered that it did not interfere their performance (51,2% «Never»; 20,9% «Very seldom»; 14% «Seldom») and about «Inability to motivate or push myself» (item 12) when 83,7% of athletes answered in the negative (37,2% «Never»; 30,2% «Very seldom»; 16,3% «Seldom»).

It was interesting to look at these athletes' motivation types to achieve success. Because it is known that success in sports largely depends on the athlete's ability to adequately assess their opportunities and work persistently to achieve their goals. Self-confidence, inner strength, and the ability to compete in the most stressful situations are also important in sports. POSQ was used as a measure of achievement goals in sports in this study. The results of the study showed a positive moderate correlation in POSQ scales (EGO orientation scale and TASK orientation scale), Pearson's correlation coefficient was r=.60, and it is statistically significant (t=4.87, df=41, p <.001).

EGO and TASK orientation scales were compared between gender, and no statistically significant differences were found (p>0,05). This finding does not support the results of previous studies which stated that women had significantly higher scores on TASK orientation than men, and men had significantly higher scores on EGO orientation (Duda (1989); Newton, Duda, (1993); Walling, Duda, (1995)).

Athletes mostly answered with either «1» (Strongly agree), «2» (Agree), or «3» (Neutral) for EGO goal orientation scale. But for TASK goal orientation scale athletes mostly answered: «1» (Strongly agree) in all questions, this answer option was selected in at least 50% of athletes' responses in this study. For example, 79% of athletes responded with the answer «Strongly Agree» to the statement «I reach personal goals» (item 9), 74,4% to the statement «I reach a Goal» (item 7); 72,1% to the statement «I overcome difficulties» (item 8); 69,8% to the statement «I work hard» (item4). It indicates that surveyed athletes have stronger task achievement goal orientation than ego goal orientation.

TASK goal orientation and EGO goal orientation scales correlated statistically significantly (r=.60), it was a medium-strength association. Correlations between EGO goal orientation and PSTS, PSCS, and DSPS scales were non-significant. (Table 1)

Correlations between TASK goal orientation and PSTS were weak (r=.27). TASK goal orientation and PSCS scales correlated statistically significantly (r=.51), it was a medium-strength association. (Table 1)

Table 1. *Correlation between SIC scales POSQ scales*

	PSTS	PSCS	DSPS	EGO	TASK
PSTS	1.00				
PSCS	.76***	1.00			
DSPS	.30*	.30*	1.00		
EGO	-.00	.07	-.09	1.00	
TASK	.27	.51***	-.02	.60***	1.00

Correlations between the POSQ scales and the six subscales of the SIC PSCS scale are shown in Table 2. Looking at the relationship between the TASK orientation scale and each of the PSCS subscales, it could be seen that the subscales had a weak correlation between the TASK goal orientation scale and subscale PSCS1 (r = .38), TASK goal orientation scale, and subscale PSCS6 (r =.35), and three subscales had a very low correlation between TASK goal orientation scale and subscale PSCS4 (r = .16); TASK goal orientation scale and subscale PSCS2 (r =.25), and TASK goal orientation scale and subscale PSCS5 (r = .29), and medium-strength association TASK goal orientation scale and subscale PSCS3 (r = .60) (Table 2).

Table 2. *Correlation between SIC scale PSCS subscales, and POSQ scales*

	EGO	TASK	PSCS	PSCS1	PSCS2	PSCS3	PSCS4	PSCS5	PSCS6
EGO	1.00								
TASK	.60***	1.00							
PSCS	.07	.51***	1.00						
PSCS1	.01	.38*	.88***	1.00					
PSCS2	.09	.25	.59***	.41**	1.00				
PSCS3	.18	.60***	.72***	.57***	.32*	1.00			
PSCS4	-.08	.16	.61***	.42**	.41**	.29	1.00		
PSCS5	.05	.29	.63***	.42**	.06	.43**	.35*	1.00	
PSCS6	.04	.35*	.53***	.27	.31*	.15	.33*	.42**	1.00

Athlete answers to each of the PSCS 3 subscale «Lack of motivation» statements have already been descriptively analyzed before. Once again, it can be emphasized that most of the respondents admitted that motivation issues never or rarely affected their performance in the competition. In general, these answers correlate with the goal orientation of the tasks and indicate a high motivation of the respondents, while a low impact of interfering performance factors (related to motivation) on the performance in the competition situations.

DISCUSSION

This study aimed to understand the relationship between the type of goal orientation and factors that interfere with sports performance in competition and training processes.

The results of the study showed that elite athletes have higher task achievement goal orientation than ego goal orientation.

The results of the study showed a statistically significant positive correlation between the type of task goal orientation of athletes and the following factors that interfere with sports performance: lack of motivation, pain intolerance, and dysfunctional thoughts and stress.

There were no found statistically significant gender differences in athletes' responses about their achievement goal orientation types. This finding did not support the findings of previous researchers who claimed that females had significantly higher scores on task orientation than males and males had significantly higher scores on EGO orientation. (Duda, (1989); Newton, Duda (1993); Walling, Duda,(1995))

There were no statistically significant differences between gender in athletes' perceptions of issues that interfere with sports performance. These results were similar to results found in the Donohue et. al., (2007) study.

A limitation of this study was the small number of elite athletes involved, and this aspect may have influenced the results of the study.

The results of this study can be used as a starting point for the development of targeted training programs for psychologists who would like to work in the field of sports psychology in Latvia in the future.

REFERENCES

Biddle, S.J.H., Akande, A., Vlachopoulos, S. and Fox, K. (1996). Towards an understanding of children's motivation for physical activity: Achievement goal orientations, beliefs about sport success and sport emotion in Zimbabwean children. *Psychology and Health*, 12, 49-55.

Biddle, S.J.H., Wang, C.K., Kavussanu, M., and Spray, C. (2003). Correlates of achievement goal orientations in physical activity: A systematic review of research. *European Journal of Sport Sciences*, vol. 3, pp.1-20.

Clancy, R. B., Herring, M. P., MacIntyre, T. E., Campbell, M. J. (2016). A review of competitive sport motivation research. *Psychol. Sport Exerc. Rev*. 27, 232–242. 10.1016/j.psychsport.2016.09.003

Donohue, B., Dickens, Y., Lancer, K., Covassin, T., Hash, A., Miller, A., and Genet, J. (2004). Improving athletes' perspectives of sport psychology consultation: a controlled evaluation of two interview methods. *Behavior Modification*, 28, pp.182-193.

Donohue, B., Silver, N.C., Dickens, Y., Covassin, Lancer, K. (2007). Development and initial psychometric evolution of the sport interference checklist. *Behavior Modification*, 31(6), 937-957.

Holgado, F. P., Navas, L., López-Núñez, M. (2010). Goal orientations in sport: a causal model *European Journal of Education and Psychology*, vol. 3, núm. 1, junio, pp. 19-32

Kremer, J., Lavallee, D., Williams, M., & Moran, A. (2004). *Sport Psychology: Contemporary Themes*. Palgrave Macmillan, pp 271 ISBN-13: 978-1403904683

Nicholls, A. R. and Polman, R. C. (2007). Coping in sport: A systematic review. *Journal of Sports Science*, vol. 25, 11-31. Review

Roberts G. C., Treasure D. C. (2001). *Advances in Motivation in Sport and Exercise*, 3E. Champaign, IL: Human Kinetics.

Treasure, D. C., & Roberts, G. C. (1994). Perception of Success Questionnaire: Preliminary validation in an adolescent population. *Perceptual and Motor Skills*, 79(1), 607-610. doi:10.2466/pms.1994.79.1.607

Weinberg R.S., Williams J.M. (1998). *Integrating and implementing a psychological skills training program. Applied sport psychology: Personal growth to peak performance.* Williams J.M.Mountain View, CA: Mayfield Publishing Company; 329-358

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MOTIVATION AND LEADERSHIP STYLE OF ATHLETES

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ABSTRACT
Long-term motivation, perceived motivational climate, and leadership style are factors related to the endurance of load, resistance to stress and sports results. The aim of this study was to reveal the relationships between leadership style, motivational climate, and long-term motivation of athletes differentiated by sex, kind of sport, and sports results. The research was done among 101 athletes practicing team sports (70 men, 31 women) with mean age 20.3 years (±5.4). We used the following questionnaires: Leadership Scale for Sport (LSS), Perceived Motivational Climate in Sport Questionnaire-2 (PMCSQ - 2), and the Test for the study of long-term motivation assessing the long-term goals and prospects. The mastery of motivational climate is strengthened by applying democratic behavior (β=.229) and structuring of team actions through training and instruction (β=.435**). The performance motivational climate is strengthened by using autocratic behavior (β=.426***) and avoiding: democratic behavior (β=-.459**), and giving positive feedback (β=-.236*). Long-term motivation increases with the dominance of the mastery motivational climate (β=.310**) and decreases with the performance motivational climate (β=-.202*). The obtained results give grounds to assume that the coach's leadership style plays a significant role in shaping the perceived motivational climate, which determines the level of athletes' long-term motivation.*

Keywords*: mastery, performance, democratic, autocratic behavior*

INTRODUCTION

Managing and maintaining adequate motivation is a significant problem in sports psychology. The majority of coaches associate motivation problems mainly with competition. However, practice shows that a large part of the difficulties is related to the management and maintenance of motivation and long-term goals during the preparation and overall sports competition activity. The quality and effectiveness of this process largely determine the duration of the athlete's sports career and competitive performance. Having sustainable long-term goals creates an inner sense of growth and development and a sense of deep meaning in daily activities (Radoslavova, Velichkov, 2005).

The social environment and individual variables influence how people think, feel, and behave. The motivational climate is related to the subjective assessment of factors from the environment. Two types of perceived motivational climate are distinguished - mastery-oriented and performance-oriented (Ames, 1992; Duda, Balaguer, 2007; Ruiz et al., 2019; Castillo-Jiménez et al., 2022).

In their research, S. Jowett and J. Duda (2008) examined the interdependence between motivational climate and the coach-player relationship in team sports. A coaching style in which role importance, cooperation, and improvement are widely advocated is associated with experiencing higher levels of closeness and engagement with the coach. A perceived ego-oriented climate, with its emphasis on punitive attitudes toward mistakes, rivalry, and unfair coaching treatment of individual athletes, is associated with low levels of group cohesion and commitment. The authors add that the coach-athlete relationship is significantly stronger when the team's motivational climate is mastery-oriented.

An adaptive motivational climate within a team is essential for nurturing good relationships among team members and optimizing group effectiveness. Understanding how a team's motivational climate is formulated requires consideration of the coach's role. In group dynamics, literature has shown, the leader creates the social environment within which a group evolves and operates across time (Chelladurai, 2007; Garcia-Calco, et al., 2014; Weinberg & Gould, 2019).

Chelladurai and Riemer (1998) proposed a multidimensional model of leadership in sports based on the fundamentals' perceptions of leadership in different social spheres.

The aim of this study is to reveal the interrelationships between long-term motivation, motivational climate, and leadership style in athletes differentiated by gender, type of sport, and ranking.

Participants

The research was done among 101 athletes (70 men, 31 women) practicing team sports - volleyball, football, basketball, handball, rugby, and field hockey; with mean age 20.3 years (±5.4). There are 61 medal-winning athletes, 40 ranked after third place. Informed consent was obtained from the parents of the examined persons under 18 years of age.

METHODS

Test for the study of long-term motivation (Radoslavova, Velichkov, 2005), which evaluates the motivational attitude towards specific events and relationships in everyday life. The questionnaire includes 10 items. Each item is rated using a 7-point Likert -type scale.

Perceived Motivational Climate in Sport Questionnaire-2 (PMCSQ-2) (Newton, Duda, & Yin, 2000), adapted to Bulgarian conditions (Domustchieva-Rogleva, 2007). It measures two factors-mastery-oriented motivational climate (it is determined by 17 questions referring to the following subscales: significance of the role, cooperative learning, effort/improvement) and performance-oriented motivation climate (it includes 16 items forming the following subscales: unequal recognition, punishment for mistakes, intra-team member rivalry).

Leadership Scale for Sport – LSS (Chelladurai & Saleh, 1980), adapted to Bulgarian conditions (Fenerova, Tosheva, Georgiev, 2011). The test contains five subscales: training and instruction, democratic behavior, autocratic behavior, social support, and positive feedback.

RESULTS

Regarding leadership style, the training and instruction subscale had the highest values among the subjects as a whole (M=4.01; SD=0.69). Authoritarian behavior had the lowest values (M=2.89; SD=0.81) (Table 1).

Table 1. *Average values of the leadership style of the studied persons overall and grouped by sex*

Variables	Training and instruction		Democratic behavior		Autocratic behavior		Social support		Positive feedback	
	M	SD	M	SD	M	SD	M	SD	M	SD
Athletes in the research	4.01	0.69	3.33	0.89	2.89	0.81	3.49	0.82	3.65	0.78
Women	4	0.79	3.11	0.94	2.52	0.61	3.39	0.85	3.32	0.88
Men	4.01	0.64	3.43	0.85	3.06	0.83	3.53	0.81	3.81	0.68

Men are more often exposed to an authoritarian leadership style from their coaches (U=3.06; α=.002) (Mann-Whitney test), but also more often receive positive feedback (U=2.31; α=.021) compared to the female group.

Coaches of rugby players most often resort to the democratic style (H=25.82; α=.000) (Kruskal-Wallis test) and provide social support (H=21.09; α=.001) (Table 2).

Table 2. *Average values of leadership style according to the type of sport*

Variables	Training and instruction		Democratic behavior		Autocratic behavior		Social support		Positive feedback	
Sports	M	SD	M	SD	M	SD	M	SD	M	SD
Volleyball	3.94	0.51	**2.67**	0.77	3.01	0.61	**2.92**	0.76	**3.41**	0.62
Basketball	4.17	0.32	**3.28**	0.77	2.76	0.32	**3.35**	0.69	**3.77**	0.67
Football	4.02	0.59	**3.21**	0.88	2.85	0.79	**3.48**	0.74	**3.49**	0.77
Handball	4.27	0.52	**3.91**	0.63	2.75	0.89	**3.89**	0.48	**4.21**	0.42
Rugby	4.15	0.65	**4.03**	0.65	3.39	1.04	**4.09**	0.66	**4.06**	0.67
Field hockey	3.03	1.29	**2.75**	0.74	2.45	0.57	**2.63**	1.11	**3.06**	1.07

Volleyball coaches rarely resort to a democratic style (M=2.67; SD=0.77) and most often - to an authoritarian style (M=3.01; SD=0.61). Field hockey players rarely receive social support from their teams (M=2.63; SD=1.11) and positive feedback (M=3.06; SD=1.07).

The activity in the medalist group is more often structured through training and instructions (U=3.17; α=.002), a democratic style is applied (U=2.62; α=.009), they receive social support (U=2.87; α=.004) and positive feedback (U=3.29; α=.001) compared to those ranked after third place (Table 3).

Table 3. *Mean values of leadership style according to ranking*

Variables	Training and instruction		Democratic behavior		Autocratic behavior		Social support		Positive feedback	
Ranking	M	SD	M	SD	M	SD	M	SD	M	SD
Medalists	**4.19**	0.58	**3.53**	0.87	2.84	0.82	**3.67**	0.81	**3.87**	0.65
Athletes ranked after 3rd place	**3.72**	0.74	**3.04**	0.85	2.79	0.79	**3.22**	0.76	**3.32**	0.83

The leading motivational climate among the subjects, in general, is the perceived mastery-oriented motivational climate (M=4.15; SD=0.52), while the perceived performance-oriented motivational climate has lower values (M=2.87; SD=0.64). In the prize-winner group, cooperative learning is statistically significantly more pronounced (U=2.72; α=.007) compared to the rank-after-third place group (Table 4).

Table 4. *Average values of the motivational climate in the studied persons grouped according to the ranking*

Variables	Significance of the role		Effort / Improvement		Cooperative learning		Unequal recognition		Punishment for mistakes		Intra-team member rivalry		MASTERY		PERFORMANCE	
Ranking	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Medalists	4.23	0.56	4.25	0.53	**4.13**	0.55	2.67	0.75	2.84	0.81	2.92	0.79	4.21	0.46	2.79	0.68
Athletes ranked after 3rd place	4.34	0.99	4.16	0.71	**3.73**	0.74	2.85	0.73	2.93	0.65	3.17	0.68	4.08	0.58	2.99	0.58

The comparative analysis of the experimental data shows that no statistically significant differences were revealed between the different groups of athletes in terms of long-term motivation.

Table 5. *Results of the correlation analysis between the components of motivational climate and leadership style*

Variables	Cooperative learning	Significance of the role	Effort / improvement	Punishment for mistakes	Intra-team member rivalry	MASTERY	PERFORMANCE	Training and instruction	Democratic behavior	Autocratic behavior	Social support	Positive feedback		
Unequal recognition	-.446**	-.342**	-.353**	.586**	.550**	-.440**	.837**	-.487**	-.341**	.247*	-.393**	-.389**		
Cooperative learning		.584**	.437**	-.239*	-.338**	.808**	-.390**	.420**	.321**		.313**	.349**		
Significance of the role			.573**			.865**	-.248*	.357**	.304**		.225*	.248*		
Effort/improvement					-.228*	.737**	-.292**	.525**	.306**		.340**	.367**		
Punishment for mistakes					.531**	-.201*	.846**	-.263**	-.228*	.334**	-.301**	-.256**		
Intra-team member rivalry						-.302**	.802**	-.295**	-.210*	.486**	-.290**	-.274**		
MASTERY							-.360**	.479**	.366**		.318**	.360**		
PERFORMANCE								-.413**	-.308**	.432**	-.405**	-.352**		
Training and instruction									.527**	-.214*	.668**	.715**		
Democratic behavior											.735**	.686**		
Social support												.742**		

* p=.05; ** p=.01

The results of the applied correlation analysis (Spearman's test) reveal positive correlations between the mastery-oriented motivational climate, long-term motivation, and its three subscales and the leadership style components: training and instructions, democratic style, social support, and positive feedback (Table 5). Negative correlations were found between the performance-oriented motivational climate and its subscales with the same components and positive correlations with the authoritarian leadership style (Figure 1).

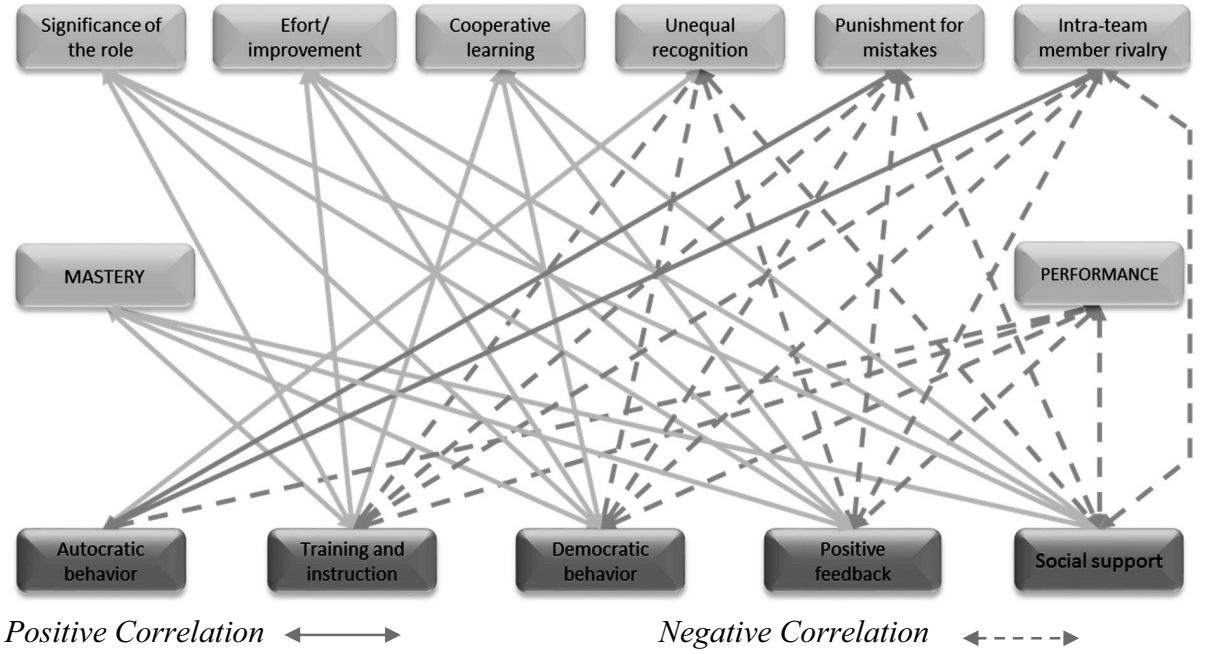

Figure 1. *Interdependencies among the components of leadership style and the motivational climate*

Positive correlations were found between the long-term motivation with mastery-oriented motivational climate and its subscales and with training and instruction and social support. Negative correlations were found between the performance-oriented motivational climate, intra-team member rivalry, and autocratic behavior with long-term motivation (Figure 2).

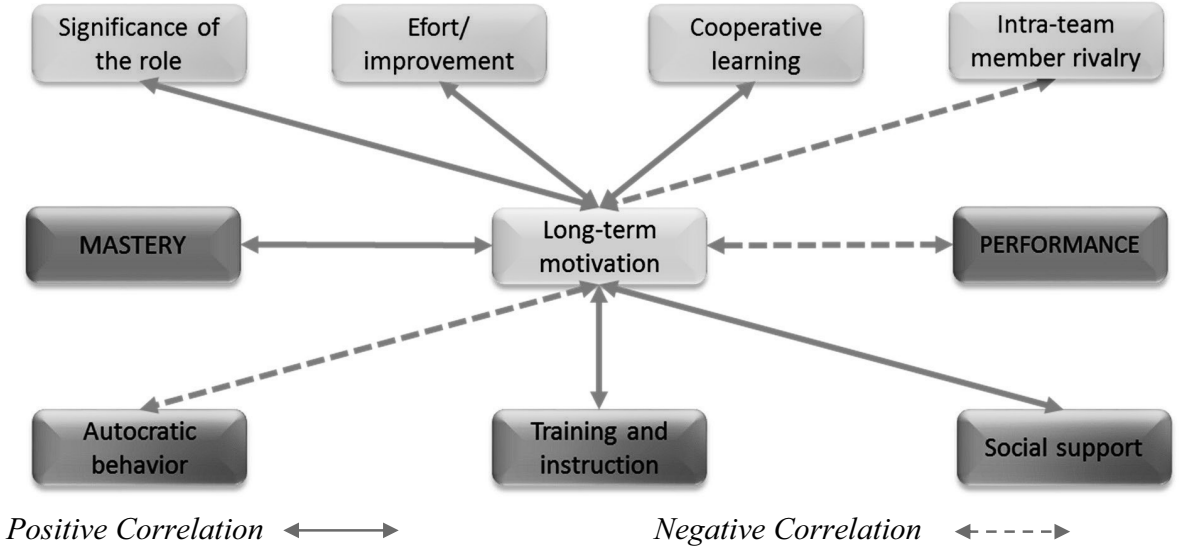

Figure 2. *Interdependencies among the components of long-term motivation, leadership style, and the motivational climate*

A stepwise regression analysis was applied to reveal the influence of the leadership style on the perceived motivational climate. In the first models, the leadership style components are the independent variables, and the mastery-oriented motivational climate and performance-oriented motivational climate were successively analyzed as dependent variables. The structuring and coordination of the team's activity through training and instructions (β=.435**) and the use of a democratic style (β=.229*) stimulates the formation of a motivational climate oriented towards mastery (Table 6).

Table 6. *Results of regression analysis – 1*

Variables	Training and instructions			Democratic style			ΔR^2
	β	t	sig .	β	t	sig .	
Mastery-oriented motivational climate	.435	5.00	.00	.229	2.119	.037	.209

The perception of a performance-oriented motivational climate is enhanced when an authoritarian leadership style is applied (β=.426***) and when a democratic style (β=-.459**) and giving positive feedback (β = -.236*) are avoided (Table 7).

Table 7. *Results of the regression analysis – 2*

Variables	Autocratic behavior			Democratic behavior			Positive feedback			ΔR^2
	β	t	sig.	β	t	sig .	β	t	sig.	
Performance-oriented motivational climate	.43	5.00	.000	-.46	-5.68	.000	-.24	-2.13	.000	.39

The following models examine the influence of perceived motivational climate on long-term motivation. Long-term motivation increases with the dominance of the mastery motivational climate (β=.310 **) and decreases with the performance motivational climate. (β=-.202*) (Table 8).

Table 8. *Results of the regression analysis – 3*

Variables	Mastery-oriented motivational climate			ΔR^2	Performance-oriented motivational climate			ΔR^2
	β	t	sig.		β	t	sig.	
Long-term motivation	.31	3.25	.002	.96	-.202	2.05	.043	.041

DISCUSSION

This study is aimed at revealing the characteristics of long-term motivation, the perceived motivational climate, and the leadership style applied to team sports athletes. Structuring through training and instruction, as well as giving positive feedback, are outlined as leading components. Other studies have established similar trends (Iancheva & Prodanov, 2019).

The perceived mastery-oriented motivational climate is leading among the surveyed persons in general. The results confirm what was found in other studies (Mitsova, 2019; Savcheva & Domuschieva-Rogleva, 2019).

Structuring through training and instruction, applying a democratic style, giving social support and positive feedback, and cooperative learning are statistically significantly more pronounced in the group of medalists.

The established trends in this study give reason to assume that the coach's leadership style plays a significant role in forming the perceived motivational climate. Applying a democratic style and structuring team actions through training and instruction leads to a perception of a mastery-oriented motivational climate, which is associated with a higher level of satisfaction with sports activities and an increase in intrinsic motivation.

Adhering to authoritarian behavior and avoiding a democratic style and positive feedback fosters a perception of a performance-oriented motivational climate. Long-term motivation increases when a mastery-oriented motivational climate dominates and decreases when team members perceive the motivational climate as performance-oriented.

CONCLUSION

The research findings on long-term motivation, leadership style, and perceived motivational climate have significant applied value. They are a valuable guide for coaches regarding using certain aspects of leadership style to form an appropriate motivational environment related to optimal sports performance and overall satisfaction with sports activities.

REFERENCES

Ames, C. (1992). Achievement goals, motivational climate, and motivational processes. In G. Roberts (Ed.), *Motivation in sport and exercise*. Champaign, IL: Human Kinetics. pp. 161- 176.

Castillo-Jiménez, N., López-Walle, J.M., Tomás, I., Tristán, J., Duda, J.L., Balaguer, I. (2022). Empowering and Disempowering Motivational Climates, Mediating Psychological Processes, and Future Intentions of Sports Participation. Int. *J. Environ. Res. Public Health*, 19, 896. https://doi.org/10.3390/ijerph19020896

Chelladurai, P. (2007). Leadership in Sports. *Handbook of sport psychology, 3rd ed.*, pp. 113-135.

Chelladurai, P., Riemer, H. (1998). Measurement of leadership in sports. In J. L. Duda (Ed.), *Advances in sport and exercise psychology measurement*. Morgantown, WV: Fitness Information Technology. pp. 227–253

Chelladurai, P., Saleh, S. (1980). Dimensions of leader behavior in sports: development of a leadership scale. *Journal of Sport Psychology, 2.*

Domuschieva-Rogleva, G. (2007). Aprobatsia na testa za vazpriet motivatsionen klimat (PMCSQ - 2) v balgarski uslovia. *Lichnost. Motivatsia. Sport. Tom 12*, NSA PRES (in Bulgarian)

Duda, J. L., Balaguer, I. (2007). Coach-Created Motivational Climate. In S. Jowette & D. Lavallee (Eds.), *Social Psychology in Sport* . Human Kinetics. pp. 117–130

https://doi.org/10.5040/9781492595878.ch-009

Fenerova, D., Tosheva, I., Georgiev, M. (2011). Adaptatsia na testa za otsenka na liderskia stil v sporta - LSS (Chelladurai and Saleh, 1980*) Lichnost. Motivatsia. Sport*. Tom 16, NSA PRES (in Bulgarian)

Garcia-Calco, T., Leo, F. M., Gonzales-Ponce, I., Sanchez-Miguel, P. A., Mouratidis, A., Ntoumanis, N. (2014). Perceived coach-created and peer-created motivational climate and their associations with team cohesion and athlete satisfaction: Evidence from a longitudinal study. *Journal of Sports Sciences*, 32(18), 1738–1750. doi:10.1080/02640414.2014.918641

Iancheva, T., Prodanov, G. (2019). Emotional Intelligence and Leadership Style Among Bulgarian Football Coaches. *Journal of Applied Sports Sciences* Vol. 2, pp. 63-76, ISSN 2534-9597 (Print), ISSN 2535-0145 (Online).

Jowett, S., Duda, J. L. (2008). The Psychological Interface Between the Coach-Created Motivational Climate and the Coach-Athlete Relationship in Team Sports, *Sport Psychologist* 22(4):423.

Mitsova, I. (2019). Reciprocity between goal orientation and motivational climate in different groups of athletes, *Proceeding book of International scientific congress "Applied Sports Sciences"* 15-16 November 2019, ISBN (Print): 978-954-718-602-6 , ISBN (Online): 978-954-718-601-9, 231-234; DOI:10.37393/ICASS2019/44

Radoslavova, M., Velichkov, A. (2005) *Metodi za psihodiagnostika*, Pandora prim, Sofia (in Bulgarian)

Ruiz, M.C., Robazza, C., Tolvanen, A., Haapanen, S., Duda, J.L. (2019) Coach-Created Motivational Climate and Athletes' Adaptation to Psychological Stress: Temporal Motivation-Emotion Interplay. *Front. Psychol.* 10:617. doi: 10.3389/fpsyg.2019.00617

Savcheva, E., Domuschieva-Rogleva, G. (2019). Motivatsionni aspekti na zanimaniyata sas sport pri fehtovachi. V: *Lichnost. Motivatsia. Sport. T. 23.* NSA Pres, Sofia, s.65-74. ISBN: 978-954-718-576-0 (in Bulgarian)

Weinberg, R.S., Gould, D. (2019). *Foundations of sport and exercise psychology*. Champaign, Human Kinetics.

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PERCEIVED MOTIVATIONAL CLIMATE AND SATISFACTION OF SPORTS ACTIVITY AMONG COMPETITORS FROM TEAM SPORTS

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ABSTRACT
*Satisfaction is seen as an important determinant of motivation for sports. The motivational climate is related to the subjective assessment of environmental factors. The aim of this study was to reveal the relationships between motivational climate and satisfaction of athletes differentiated by sex, kind of sport, and sports results. The research was done among 101 athletes practicing team sports (70 men, 31 women) with a mean age of 2.3 years (±5.4). We used the following questionnaires: Perceived Motivational Climate in Sport Questionnaire-2 (PMCSQ-2) and Athlete Satisfaction Questionnaire (ASQ). Satisfaction with individual performance is enhanced by a perceived motivational climate oriented towards mastery (β=.440**), cooperative learning (β=.424**), the importance of each athlete for the success of the team (β=.201*), investment of effort and improvement (β=.411**). The structuring of team actions through training and instruction is enhanced by perceiving a motivational climate oriented towards mastery (β=.208*) and cooperative learning (β=.263**). Unequal recognition reduces satisfaction with team performance (β=-.232*), but collaborative learning (β=.298**), effort and improvement (β=.267**), and mastery of motivational climate (β=.283**) increase it. Satisfaction with personal treatment decreases with the dominance of a performance motivational climate (β=-.216**) and application of punishment for mistakes (β=-.208**) and increases with effort and improvement (β=.283**). The results of this study give grounds to assume that the perceived motivational climate plays a significant role in shaping satisfaction with sports activities. They are a guide to creating an appropriate motivational climate related to optimal sports performance and satisfaction.*

Keywords*: training and instruction, team performance, mastery, performance*

INTRODUCTION

Research on motivation in the field of sports is particularly relevant because it is seen as a basic prerequisite for achieving success. A significant number of studies in the field of sport psychology have attempted to explain the impact of various motivational attitudes on sports performance. One of the main factors that affect the athlete's satisfaction is the motivational climate. The motivational climate in sports is referred to the psychological atmosphere and indicates what the coach does and says and how they structure the environment in training and competitions.

Research has consistently shown that motivational climates are related to the quality of motivation of athletes and their enjoyment of sports activities (Appleton, Duda, 2016). The social environment and individual variables influence the way people think, feel, and behave. The motivational climate is related to the subjective assessment of factors from the environment. Two types of perceived motivational climate are distinguished - mastery-oriented and performance-oriented (Ames, 1992; Duda, Balaguer, 2007; Ruiz et al., 2019; Castillo-Jiménez et al., 2022). In the motivational climate in sport, two dimensions are observed: the first refers to a task involving a motivational climate, in which the coach emphasizes cooperative learning between teammates, effort, and skills improvement, and considers that all athletes have an important role in the team. The second dimension refers to the ego involving motivational climate, where the coach encourages rivalry, demonstrates unequal recognition of athletes based on their ability, and uses punishment for mistakes (Newton, Duda, 2000; Harwood, Thrower, 2020).

Previous research has generally identified a mastery climate as more advantageous in sports settings. For example, a systematic review identified that mastery climate was positively associated with positive affective states (e.g., satisfaction and performance climate to negative affective states (Harwood et al., 2015; Ruiz et al., 2019).

Satisfaction is seen as a significant aspect of engaging in sports activities (Tiggemann, Williamson, 2000; Ryan, Deci, 2007; Burns et al., 2021; Domuschieva-Rogleva, 2020). It is a positive affective state, which is the result of a cognitive assessment that what is received or experienced meets or exceeds certain personal standards. Satisfaction can be considered at different

levels - from more general (e.g., life satisfaction) to more specific areas (e.g., athlete satisfaction, which may include body shape satisfaction, coach and leader satisfaction to specific aspects (e.g., achieving certain goals and making strategic decisions) (Baker et al., 2003; Drakou, 2006).

Athlete satisfaction is seen as a quality of life or an attitude to the organization and management of the team. It is a necessary condition for participation in sports and a successful and long career. Lack of it can lead to redirection of the athlete to other areas of activity, containing potential conditions for success and satisfaction (Riemer, Chelladurai, 1998; Adie et al., 2021). Satisfaction with the activity of a given sport is closely related to the subjective assessment of the athlete for the benefits of this activity, which are related to several main areas: self-knowledge, life experience, physical and mental health, public recognition and social contacts, satisfaction and inner harmony, personal cultivation.

The aim of this study is to reveal the interrelationships between motivational climate and satisfaction in athletes differentiated by gender, type of sport, and ranking.

METHODOLOGY

Participants

The research was done among 101 athletes (70 men, 31 women) practicing team sports - volleyball, football, basketball, handball, rugby, and field hockey; with a mean age of 20.3 years (±5.4). Informed consent was obtained from the parents of the examined persons under 18 years of age. There are 61 medal-winning athletes, with 40 ranked after third place.

Methods

*1. Perceived Motivational Climate in Sport Questionnaire-2 (*PMCSQ-2) (Newton, Duda, & Yin, 2000), adapted to Bulgarian conditions (Domustchieva-Rogleva, 2007). It measures two factors - mastery-oriented motivational climate (it is determined by 17 questions referring to the following subscales: significance of the role, cooperative learning, effort/improvement) and performance-oriented motivation climate (it includes 16 items forming the following subscales: unequal recognition, punishment for mistakes, intra-team member rivalry).

2. Athlete Satisfaction Questionnaire – ASQ, adapted to Bulgarian conditions (Georgiev, Fenerova, Tosheva, 2011). The methodology used in the present study consists of four subscales: training and instructions, team performance, individual performance, and personal treatment. Two of the subscales reflect satisfaction with the training process, and the other two reflect satisfaction with the achievements.

SPSS 25.0 was used for statistical processing. A set of statistical procedures was applied: descriptive statistics, comparative analysis (Mann-Whitney (U) - for two samples, Kruskal-Wallis (H) test - for more than two groups of subjects), correlation, and regression analysis.

RESULTS

The comparative analysis of the experimental data shows that there were no statistically significant differences between the subjects differentiated by gender and sports discipline in terms of motivational climate.

The leading motivational climate among the subjects, in general, is the perceived mastery-oriented motivational climate (M=4.15; SD=0.52), while the perceived performance-oriented motivational climate has lower values (M=2.87; SD=0.64) (Table 1).

The highest values for the individual components that determine the two types of motivational climate are found for the role significance subscale (M=4.44; SD=0.52), characterizing the mastery-oriented motivational climate in the group of women.
The lowest values were observed for the unfair recognition subscale (M=2.71; SD=0.74), defining the performance-oriented motivational climate.

The leading motivational climate among the studied persons, grouped according to the practiced sport, is the mastery-oriented motivational climate, with the result being the highest for handball players (M=4.35; SD=0.39) and the lowest for the studied volleyball players (M=4.01; SD=0.53). In both groups of athletes, the exact opposite trend is observed in terms of the perceived performance-oriented motivational climate - in the group of handball players - M=2.65; SD=0.54, and for volleyball players - M=3.13; SD=0.63.
The studied individuals, differentiated according to ranking, higher levels of the perceived maste-

ry-oriented motivational climate and lower levels of the performance-oriented motivational climate were found in the group of medalists.

In the prize-winner group, cooperative learning is statistically significantly more pronounced (U=2.72; α=.007) compared to the rank-after-third place group (Table 1).

Table 1. *Average values of the motivational climate in the studied persons grouped according to the ranking*

Variables	Significance of the role		Effort / Improvement		Cooperative learning		Unequal recognition		Punishment for mistakes		Intra-team member rivalry		MASTERY		PERFORMANCE	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Athletes in the research	4.28	0.76	4.21	0.61	3.97	0.66	2.71	0.75	2.88	0.75	3.02	0.76	4.15	0.52	2.87	0.64
Medalists	4.23	0.56	4.25	0.53	4.13	0.55	2.67	0.75	2.84	0.81	2.92	0.79	4.21	0.46	2.79	0.68
Athletes ranked after 3rd place	4.34	0.99	4.16	0.71	3.73	0.74	2.85	0.73	2.93	0.65	3.17	0.68	4.08	0.58	2.99	0.58

*** Darker numbers in this and the following tables indicate the presence of statistically significant differences in the studied variables between individual groups*

Regarding satisfaction with sports activity, the leading factor among the subjects, in general, is training and instructions (M=3.11; SD=0.74), followed by the individual performance factor (M=3.09; SD=0.70). The other two factors: the coach's personal treatment of the athlete (M=3.01; SD=0.74) and team performance (M=2.99; SD=0.72), have lower values.

Females had higher values for the team performance factor (M=3.11; SD=0.84), while the training and instruction factor (M=3.14; SD=0.63) was higher for males.

The results of the comparative analysis between the groups of subjects revealed that among the athletes, divided according to the type of sport practiced, statistically significant differences were observed in terms of team performance (H=11.365; p=.045), individual performance (H=11.120; p=.049), the coach's personal attitude towards the athlete (H=12.153; p=0.033). Athletes practicing rugby have the highest values of satisfaction with sports activity, and athletes practicing field hockey have the lowest (Table 2).

Table 2. *Average values of the satisfaction in the studied persons grouped according to the sport*

Variables	Training and instruction		Team performance		Individual performance		Personal treatment	
Sport	M	SD	**M**	SD	**M**	SD	**M**	SD
Volleyball	3.00	0.69	**3.30**	0.45	**3.30**	0.76	**2.83**	0.70
Basketball	3.23	0.53	**2.42**	0.56	**2.85**	0.57	**3.17**	0.39
Football	3.13	0.75	**3.04**	0.74	**3.01**	0.74	**2.99**	0.76
Handball	3.55	0.56	**2.82**	0.73	**2.28**	0.54	**3.32**	0.47
Rugby	3.30	0.60	**3.30**	0.63	**3.43**	0.47	**3.38**	0.49
Field hockey	2.23	1.01	**2.57**	0.78	**2.52**	0.74	**2.00**	0.93

The most numerous differences are observed in the competitors grouped according to ranking. In the group of medalists, they were statistically significantly more satisfied compared to those ranked after third place in all four aspects: training and instruction (U=2.71; p=.007), team performance (U=2.65; p= .008), individual performance (U=3.28; p=.001) and personal attitude of the coach towards the athlete (U=2.93; p=.003) (Table 3).

Table 3. *Average values of the satisfaction in the studied persons grouped according to ranking*

Variables	Training and instruction		Team performance		Individual performance		Personal treatment	
Ranking	**M**	SD	**M**	SD	**M**	SD	**M**	SD
Medalists	**3.30**	0.61	**3.15**	0.69	**3.28**	0.62	**3.22**	0.60
Athletes ranked after 3rd place	**2.84**	0.84	**2.75**	0.71	**2.80**	0.72	**2.70**	0.83

Correlation analysis (Spearman's test) was applied to reveal the relationships and interdependencies between the studied variables. The analysis of the experimental data showed certain interdependencies between the studied constructs (Figure 1). Positive interrelationships were found between the mastery-oriented motivational climate and its subscales: role significance, effort/improvement, collaborative learning, and the components of satisfaction with the sports activity: training and instruction, team performance, individual performance, and personal attitude of the coach to the athlete. Mastery-oriented motivational climate has a positive correlation with training and instruction (r=.424; p=.01), team performance (r=.257; p=.01), individual performance (r=.364; p= .01) and the coach's personal attitude towards the athlete (r=.364; p=.01). These results are also confirmed in other studies (Domuschieva-Rogleva, Yancheva, Georgiev, 2019). In addition, negative correlations were found between performance-oriented motivational climate and its subscales: unfair recognition, punishment for mistakes, intragroup rivalry, and satisfaction components. The more pronounced the performance-oriented motivational climate, the lower the satisfaction related to training and instruction (r=-.397; p=.01), team performance (r=-.204; p=.05), the coach's personal attitude towards the athlete (r=-.334; p=.01).

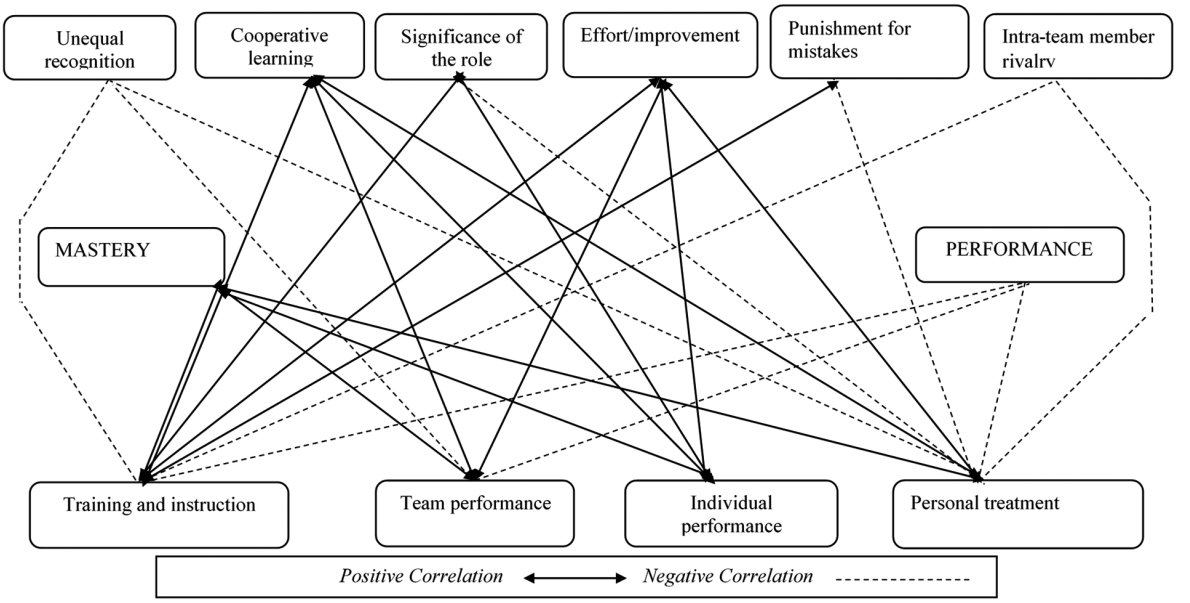

Figure 1. *Interdependencies among the components of the motivational climate and satisfaction*

A stepwise regression analysis was applied to reveal the influence of the perceived motivational climate on satisfaction. The different types of perceived motivational climate components are the independent

variables. The components of satisfaction were analyzed systematically as dependent variables.
The structuring of team actions through training and instruction is enhanced by the perception of a motivational climate oriented towards mastery (β=.208*) and cooperative learning (β=.263**) (Table 4).

Table 4. *Results of regression analysis – 1*

Variables	Cooperative learning				MASTERY			
	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2
Training and instruction	.263	2.716	.008	0.069	.208	2.119	.037	0.043

The results showed that a low level of unequal recognition reduces satisfaction with team performance (β=-.232*), but cooperative learning (β=.298**), effort, and improvement (β=.267**), and mastery motivational climate (β=.283**) increase it (Table 5).

Table 5. *Results of regression analysis – 2*

Variables	Unequal recognition				Cooperative learning				Effort/improvement				MASTERY			
	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2
Team performance	-.232		.020	0.054	.298	3.110	.002	0.089	.267	2.754	.007	0.071	.283	2.935	.004	0.80

Satisfaction with individual performance is enhanced by a perceived motivational climate oriented towards mastery (β=.440**), cooperative learning (β=.424**), the importance of each athlete for the success of the team (β=.201*), investment of effort and improvement (β=.411**) (Table 6).

Table 6. *Results of regression analysis – 3*

Variables	Effort/improvement				Cooperative learning				Significance of the role				MASTERY			
	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2
Individual performance	.411	4.480	.000	0.169	.424	4.657	.000	0.180	.201	2.043	.044	0.040	.440	4.873	.000	0.193

Satisfaction with personal treatment decreases with the dominance of a performance motivational climate (β=-.216**) and application of punishment for mistakes (β=-.208**) and increases with effort and improvement (β=.283**) (Table 7).

Table 7. *Results of regression analysis – 4*

Variables	PERFORMANCE				Punishment for mistakes				Effort/improvement			
	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2	β	t	sig.	Δ R^2
Personal treatment	-.216	-2.196	.03	0.046	-.208	-2.119	.037	0.043	.283	2.932	.004	0.08

DISCUSSION

Within the framework of Achievement Goal Theory, the objective of this study was to analyze the relationship between the players' perception of the motivational climate and their satisfaction with sports activity.

The perceived mastery-oriented motivational climate is leading among the surveyed persons in general. The results confirm what was found in other studies (Mitsova, 2019; Savcheva, Domuschieva-Rogleva, 2019).

Structuring through training and instruction, as well as giving positive feedback, are outlined as leading components. Other studies have established similar trends (Iancheva, Prodanov, 2019; Domuschieva-Rogleva, Yancheva, 2021).

It was found that all four aspects of satisfaction: training and instruction, team performance, individual performance, and personal attitude of the coach to the athlete, were statistically significantly more pronounced in the group of medalists.

This has important implications for coaches, indicating the intervening mechanisms to achieve a future intention of staying in sports practice. The players' perception of the motivational climate is definitely a key element to achieving the satisfaction of sports activity and their desire to continue or drop out of sports participation. Specifically, the results demonstrate the importance of creating empowering climates and avoiding disempowering climates to achieve the quality of participation in team players.

This study provides empirical evidence that creating an empowering environment in team sports allows players to live satisfying experiences. When coaches create disempowering climates, they encourage players to have negative experiences in their sport and to want to drop out of it.

CONCLUSION

This research, carried out in a sports context, suggests that coaches should generate a mastery motivational climate and avoid promoting a performance motivational climate since they are key people who can influence athletes' satisfaction with sports activity.

REFERENCES

Adie, J. W., Duda, J. L., & Ntoumanis, N. (2021). Perceived coach-autonomy support, essential need satisfaction and the well and ill-being of elite youth soccer players: A longitudinal investigation. *Psychology of Sport and Exercise,* 13, p. 51–59.

Ames, C. (1992). Achievement goals, motivational climate, and motivational processes. In G. Roberts (Ed.), *Motivation in sport and exercise* (pp. 161- 176). Champaign, IL: Human Kinetics.

Appleton, P.R.; Duda, J.L. (2016). Examining the interactive effects of coach-created empowering and disempowering climate dimensions on athletes' health and functioning. *Psychol. Sports Exerc.*, 26, 61–70.

Baker, J., Yardley, J., & Côté, J. P. (2003) Coach behaviors and athlete satisfaction in team and individual sports. *International Journal of Sport Psychology,* 34, p. 226–239.

Burns, G. N., Jasinski, D., Dunn, S. C., & Fletcher, D. (2021). Athlete identity and athlete satisfaction: The nonconformity of exclusivity. *Personality and Individual Differences,* 52 (3), p. 280–284. doi:10.1016/j.paid.2011.10.020.

Castillo-Jiménez, N., López-Walle, J.M., Tomás, I., Tristán, J., Duda, J.L., Balaguer, I. (2022). Empowering and Disempowering Motivational Climates, Mediating Psychological Processes, and Future Intentions of Sport Participation. Int. J. Environ. Res. *Public Health,* 19, 896. https://doi.org/10.3390/ ijerph19020896.

Georgiev, M., Tosheva, I., Fenerova, D. (2011). Adaptatsiya na testa za otsenka na udovletvorenostta na sportista, *Lichnost. Motivatsiya. Sport*, 16, NSA PRESS, S., pp. 121-125.

Domuschieva - Rogleva, G. (2007). Aprobacia na testa za vazpriet motivacionen klimat (PMCSQ-2) v balgarski usloviia. V*: Lichnost, motivaciia, sport*. T. 12, NSA, S.., ISBN 978-954-718-208-0, 2007, 46-53 (in Bulgarian).

Domuschieva-Rogleva, G. (2020). Vzaimovrьzki mezhdu udovletvorenostta ot zanimaniyata sas sport i psikhichnoto blagopoluchie pri sportistite, V: *Liderstvo i organizatsionno razvitie;* UI „Sv. Kl. Okhridski", S., str. 717-725.

Domuschieva-Rogleva, G., Yancheva, M, Georgiev, M. (2019) Vazpriet motivatsionen klimat I udovletvorenost ot sportnata deinost pri sustezateli po dzhudo V: *Lichnost, motivatsia, sport,* T. 23, NSA, S., 28-43 (in Bulgarian).

Domuschieva-Rogleva, G., Yancheva, M. (2021). Sambo competitors' sport motivation and satisfaction, *Trakia Journal of Sciences*, Vol. 19, Suppl. 1, 2021.

Drakou, A., Kambitsis, C., Charachousou, Y., & Tzetzis, G. (2006). Exploring life satisfaction of sports coaches in Greece. *European Sport Management Quarterly*, 6 (3), p. 239–252.

Duda, J. L., Balaguer, I. (2007). Coach-Created Motivational Climate. In S. Jowette & D. Lavallee (Eds.), *Social*

Psychology in Sport (pp. 117–130). Human Kinetics.

Harwood, C.G., Keegan, R.J., Smith, J.M., Raine, A.S. (2015). A systematic review of the intrapersonal correlates of motivational climate perceptions in sport and physical activity. *Psychol. Sports Exerc.* 18, 9–25.

Harwood, C. G., & Thrower, S. N. (2020). Motivational climate in youth sports groups. In M. W. Bruner, M. A. Eys, & L. J. Martin (Eds.), *The power of groups in youth sport* (pp. 145–163). Elsevier Academic Press. https://doi.org/10.1016/B978-0-12-816336-8.00009-3

Iancheva, T., Prodanov, G. (2019). Emotional Intelligence And Leadership Style Among Bulgarian Football Coaches. *Journal of Applied Sports Sciences* Vol. 2, pp. 63-76, ISSN 2534-9597 (Print), ISSN 2535-0145 (Online).

Mitsova, I. (2019). Reciprocity between goal orientation and motivational climate in different groups of athletes., *Proceeding book of International scientific congress "Applied Sports Sciences"* 15-16 November 2019, ISBN (Print): 978-954-718-602-6, ISBN (Online): 978-954-718-601-9, 231-234; DOI:10.37393/ICASS2019/44.

Newton, M., Duda, J.L., Yin, Z. (2000). Examination of the psychometric properties of the Perceived Motivational Climate in Sport Questionnaire-in a sample of female athletes. *J. Sports Sci.*, 18, 275–290.

Riemer, H., Chelladurai, P. (1998). Development of the Athlete Satisfaction Questionnaire. *Journal of Sport and Exercise Psychology,* 20:2, 1998. 127-156.

Ruiz, M.C., Robazza, C., Tolvanen, A., Haapanen, S., Duda, J.L. (2019). Coach-Created Motivational Climate and Athletes' Adaptation to Psychological Stress: Temporal Motivation-Emotion Interplay. *Front. Psychol.* 10:617. doi: 10.3389/fpsyg.2019.00617

Ryan, R. M., & Deci, E. L. (2007). Active human nature: Self-determination theory and the promotion and maintenance of sport, exercise, and health. In M. S. Hagger & N. L. D. Chatzisarantis (Eds.), *Intrinsic motivation and self-determination in exercise and sport,* Champaign, IL: Human Kinetics, p. 1–19.

Savcheva, E., Domuschieva-Rogleva, G. (2019). Motivatsionni aspekti na zanimaniyata sas sport pri fehtovachi. *V: Lichnost. Motivatsia. Sport. T. 23. NSA Pres, Sofia*, s.65-74. ISBN: 978-954-718-576-0 (in Bulgarian)

Tiggemann, M., & Williamson, S. (2000). The effect of exercise on body satisfaction and self-esteem as a function of gender and age. *Sex Roles,* 43, p. 119–127.

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THE INFLUENCE OF THE COACH LEADERSHIP STYLE AND MOTIVATIONAL CLIMATE ON THE PERCEPTION OF SUPPORT FOR AUTONOMOUS BEHAVIOR

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ABSTRACT
This report presents the results of a study which aims to reveal the influence of the leadership style of the coach and the motivational climate in the sports team on the perceived support for autonomous behavior.
The leadership style of the coach is seen as a multidimensional construct including: training and instruction, democracy and authoritarianism in decision making, social support and positive feedback.
The motivational climate is related to the focus on mastery, improvement and performance.
The need for autonomous behavior is one of the three universal psychological needs that ensure psychological growth and development (Deci & Ryan, 2017).
The following methodologies have been used in the research realization: Leadership Scale for Sports (Chelladurai, Saleh, 1980); Perceived Motivational Climate in Sport Questionnaire 2 (Newton, Duda & Yin, 2000); The Sports Climate Questionnaire (SDT, Sports Climate Questionnaire, n.d.).
The personal attitude of the coach (β = .44), social support (β = .26), democratic style (β = .15) and mastery-oriented motivational climate (β = .13) have a significant influence on the perception of support for autonomous behavior.
The results present the subjective assessment of sportsmen for the importance of each of the dimensions of coaching behavior and the perceived motivational climate on the perceived support for autonomous behavior.

Keywords*: Motivation, Self-determination Theory, Autonomy Support, Coach, Sport.*

INTRODUCTION

The subject of leadership and leadership behavior over the years has been the subject of constant in-depth analyzes and statements of varied content. Famous people who have devoted their lives to science give different definitions of what leadership is. According to Friedrich Nietzsche (1844-1900), morality is the weapon of the weak, and no true leader should possess it. Sigmund Freud (1856-1939) emphasized that the masses need a leader to rule them, as a family needs an authoritarian father.

Nowadays, the definition of a leader or manager can be viewed from different perspectives, depending on the social circle in which the leader has fallen. For this reason, in order to define the concept of leadership, it is important to note the characteristics of the leader's manifestation, the context of the situations in which he finds himself and the environment with which he communicates.

The German Kurt Lewin has the main credit for the development and definition of social psychology as an independent field. It holds to the notion that different social behaviors operate differently, depending on the group and the dynamics within it. Thanks to the numerous social experiments made in the first half of the 20th century, Levin and his colleagues arrived at the theory of leadership, which later became applicable in various organizations and spheres of human relationships. His theory defines three basic leadership behaviors - democratic, autocratic and liberal. In the course of the analyses, the definition of situational leadership, which was first introduced as a behavior by specialists in the field of human resources, also creeps in. Although at the beginning of his studies, the German psychologist proved the theory of leadership behavior mainly in social organizations, nowadays we can already say that this theory is applicable to any human group.

Sports is an industry in which all three main patterns discovered by Levin can be very clearly and distinctly observed. In democratic leadership behavior, the coach maintains constant contact and feedback with the players, takes into account their opinion, and very often the decision- making towards a certain goal is collective. In certain social groups in sports, such behavior can increase teamwork and make players feel more significant.

The leadership style of the coach, which is characterized by independent decision-making, setting goals and actions to achieve them, without, however, having a large part in their realization, is called autocratic. Players can very rarely get feedback or be encouraged in their attempts to act on their own feelings about the situation. Leaders who exercise an autocratic style define the rules themselves, assign roles and conditions for achieving the goal. Players often hear negative criticism of their behavior or attitude towards the process. Despite these perceptions, experiments carried out since Kurt Lewin's time prove that this style of management does not always lead to a negative environment in the group.

Laissez-faire, or "liberalism" for short, does not imply that leaders adhering to this style of behavior apply an active approach to action. Liberalism is considered the least effective, although it is often found in sports circles. In this case, the coach finds a solution to a given situation, but does not impose his opinion on the players. More often than not, he lets everyone decide for themselves. As much as it sounds like an opportunity for players to develop their initiative, the implementation of this style in many cases is the cause of a weakening of discipline. In team sports, this can be detrimental to the team's desire to achieve goals set by management. Each of the mentioned leadership models has its advantages and disadvantages, depending on the behavior, relationships and goals of the social group.

In order to summarize the generally accepted understanding of leadership behavior, in 1998 scientists, in the person of Chelladurai & Riemer, developed and proposed a model called the "Multidimensional Model of Leadership". According to Chelladurai (1998), the effectiveness of coaching behavior is a function of the situation, the group members, and the attitude of their leader. Different circumstances such as team organization and goals, social norms, attitudes and cultural values would cause a coach to behave in a certain way. It is obvious that during the training process and official competitions there are many different styles of behavior in trainers, but we cannot claim which of them will have a consistent positive result.

Team members and their personality traits (age, gender, playing experience) primarily influence Athletes' preferred coaching behavior, while the coach's personality traits account for his actual behavior (Chelladurai & Riemer, 1998). Preferred leadership behavior stems from two main interrelated strands - situational specificity and group member behavior.

The required behavior of the leader outlines the expected behavior in the organization, decision making, age characteristics, etc.

Actual behavior is a combination of the characteristics of the leader, the different behaviors he implements, and the satisfaction of the group.

Research on leadership behavior and the effects of different coaching styles on athletes is needed to provide information that mainly concerns sports clubs. This could improve the work and performance of the coaches, as well as the performance evaluation on the satisfaction of the athlete for his improvement.

The context of the sport situation, the characteristics of the coach and the athletes themselves dictate leadership behavior. In order to achieve an improvement in the athlete's performance, it is important for the coach to choose the leadership style well. It is considered by many specialists to be an important element in achieving success in leading a team. In one situation or another, most coaches use different leadership skills, and at certain times some of them are more appropriate. Therefore, when a coach can judge the circumstances and his management style well, he has a powerful weapon when it comes to communication with the players.

The behavior of the players is related to the task to be performed, the personality traits of each one, the attitude towards the coach and the need for independence. The adopted leadership behavior is partly determined by the characteristics and personal qualities of the leader, but also by the needs and preferences of the group. Therefore, to some extent, the leader must comply with all these conditions. All components of his behavior play a significant role in determining the outcome of the interaction between coaches and athletes.

Within a social group, there are various variables such as the contestants' way of thinking, behavior and attitude towards the process. These factors influence the motivational climate. It can be defined

in two directions – directed at mastery and at performance (Ames, 1992; Duda, Balaguer, 2007). In both cases, the attitude of the management, the coach and his teammates towards the competition and the training process, the requirements and the way to achieve the set goals, the support of the audience and his relatives are important for the athlete. If a mastery-oriented motivational climate is adopted in the team, then surely the improvement of specific technical skills and habits, as well as the effort put into doing so, would be accepted as high performance, even when mistakes are made.

In the other case, the performance of the athletes relative to the rivalry in a given competition is observed. Competitors who perform at a high level receive a high score. Making mistakes that could lead to a bad team or individual result are not accepted. Logically, experts define a mastery-oriented motivational climate as favorable as far as a good relationship between coach and competitor is concerned.

The athletes' need for independence and autonomy is also largely related to the coach's leadership style. Self-determination theory (Deci & Ryan, 1985a; Ryan & Deci, 2000) is based on a person's desire to develop according to their inner beliefs and needs. According to this theory, the basic needs for personal growth are: autonomy, competence and relatedness. An athlete's autonomous behavior can be influenced by the coach's leadership style. In most cases, support for autonomous behavior is received by athletes whose coaches exercise a democratic or liberal style of leadership behavior.

METHODOLOGY AND DATA ANALYSIS

The present research is aimed at establishing the influence of leadership style of the coach and motivational climate on the perception of support for autonomous athlete behavior. The coach, with his leadership style, behavior, and attitude towards the athlete, with the goals he sets for the individual athletes and the team is in the basis of the perceived motivational climate, of the athlete's satisfaction and we assume that it directly or indirectly influences the perception of autonomous behavior.

The following psychological methodologies: Leadership Scale for Sports (Athlete Perception) (Chelladurai & Saleh, 1980), were used to examine the relevant psychological constructs for the present research.

Dimensions of coach competence include the criterion domains: degree of training and instruction; social support; positive feedback; democratic and authoritarian decision-making in the training process. The adapted, for Bulgarian conditions, a variant of the methodology consists of 46 items and a 5-point scale likert type. The methodology was adapted from Tosheva, Fenerova, Georgiev (2011).

Perceived Motivational Climate in Sport Questionnaire - 2 (PMCSQ - 2) (Newton, Duda & Yin, 2000). The test consists of 33 items and a 5-point scale liker type. It measures two factors:
– motivational climate, mastery oriented (or task-engaged) - includes the subscales: cooperative learning, Effort/improvement, Important role of each for team success;
– motivational climate, performance-oriented (or ego-involved) – includes the subscales: Intra team member rivalry, unequal recognition, punishment for mistakes.

The test was adapted for Bulgarian conditions (Domuschieva-Rogleva, 2007).

Sport Climate Questionnaire (SCQ). The test consists of 15 items and a seven-point Likert-type scale. It reveals the degree of support from the coach of the autonomous behavior of the athletes. A total score is obtained. High values indicate high support of autonomous behavior. (https://selfdeterminationtheory.org/sport-climate-questionnaire/ The Sport Climate Questionnaire, 5.10.2022)

Participants

170 athletes were included in the study, of which 79 were women and 91 were men. 54 of these athletes were from individual sports, 82 – from team sports, and 34 - combat sports. All participants were informed about the purpose of the study and the basis for participating in it. The athletes were over eighteen years of age. They all are active competitors.

RESULTS AND ANALYSIS

The statistical analysis of the empirical data was realized through the statistical for the social sciences IBM SPSS 25. Variational, correlational, and regression analysis.

The coach's leadership style is dominated by positive, social feedback support and training style and

instruction. With relatively high values are also the two styles – democratic and autocratic behavior (Table 1). The researched Athletes perceive their coaches as caring and responsible for their personal well-being and professional development. This is also confirmed by the results regarding the perceived motivational climate. Similar results were found by Doneva, Domuschieva-Rogleva and Yancheva in their study of the coach's leadership style and perceptions motivational climate (2021).

Table 1. *Mean values and variability of the coach leadership style*

	N	Min	Max	M	SD
Training and instructions	170	2.4	5	4.25	0.54
Democratic behavior	170	1.57	4.71	3.28	0.74
Autocratic behavior	170	1	4.5	2.48	0.67
Social support	170	1.71	5	3.72	0.74
Positive feedback	170	1.71	5	3.79	0.69

The dominant perceived motivational climate is mastery-oriented. The main goals are related to the assimilation and improvement of habits and skills and the development of sports and technical mastery. Group goals and interests come first plan. Mistakes are treated as a part of the learning and improvement process (Table 2).

Table 2. *Mean values and variability of the perceived motivational climate*

	N	Min	Max	M	SD
MASTERY Task-involving	170	2.41	5	**4.18**	0.52
Important role	170	2.43	5	4.26	0.55
Effort/improvement	170	2.33	5	4.36	0.49
Cooperative learning	170	1	5	3.93	0.78
PERFORMANCE Ego-involving	170	1.14	4.42	**2.90**	0.60
Unequal Recognition	170	1.29	5	2.85	0.85
Punishment for mistakes	170	1	4.5	2.77	0.82
Intra team Member Rivalry	170	1	4.6	3.08	0.64

The perception of support for autonomous behavior is relatively high values – M = 3.8, with a maximum value of 5.

The results of the correlation analysis reveal positive interrelationships of the support for autonomous behavior with the characteristics of the leadership style training and instructions, democratic behavior, social support, positive feedback, etc. mastery-oriented perceived motivational climate. Significant but negative correlations are established with autocratic behavior and orientation towards performance motivational climate (Table 3). The existence of interdependencies of these variables with support for autonomous behavior warrants regression analysis, through which to establish the degree and direction of influence on it.

Table 3. *Pearson`s correlations between coach leadership style perceived support for autonomous behavior and perceived motivational climate*

	Training and instructions	Democratic behavior	Autocratic behavior	Social support	Positive feedback	Task-involving	Ego-involving
Autonomy support	.525**	.533**	-.323**	.652**	.522**	.483**	-.382**

Stepwise regression analysis yielded three models sequentially. The third model includes the largest number of independent variables. It explains 50% of the variation of the dependent variable – perception of support for autonomous behavior - ΔR^2 = .51. Influence on the dependent variable is exerted by social support coach (β = .53), mastery-oriented perceived motivational climate (β =.26) and the performance-oriented perceived motivational climate. But this one motivational climate does not promote the formation of autonomous behavior (β = - .22).

CONCLUSIONS

Athletes' perceived support for autonomous behavior is significantly determined by the coach's leadership style and motivational climate. Social support, as a component of motivational climate and mastery-oriented motivational climate, has the strongest influence. A performance-oriented motivational climate negatively influences and lowers perceived support for autonomous behavior.

REFERENCES

Ames, C. (1992). *Achievement Goals, Motivational Climate, and Motivational Processes*. In G. Roberts (Ed.), Motivation in Sport and Exercise, pp. 161-176.

Chelladurai, P., & Reimer, H. A. (1998). *Measurement of leadership in sport*. In J. Duda (Ed.), Advances in sport and exercise psychology measurement, pp. 227-253. Morgantown WV: Fitness Information Technology

Chelladurai, P., Saleh, S. (1980). Dimensions of leadership behavior in sports: Development of a leadership scale. *Journal of Sport Psychology*, 2

Domuschieva-Rogleva, G. (2007). Aprobatsiya na testa za vazpriet motivatsionen klimat (PMCSQ - 2) v balgarski usloviya. V: *Lichnost, motivatsiya, sport*. Tom 12, S, NSAPRES.// Домусчиева-Роглева. (2007). Апробация на теста за възприет мотивационен климат (PMCSQ - 2) в български условия. В: *Личност, мотивация, спорт*. Том 12, С, НСАПРЕС. Domuschieva-Rogleva. (2007).

Doneva, V., Domuschieva-Rogleva, G., Yancheva, M. (2021). Liderski stil i motivatsionen klimat pri sportisti. V: *Lichnost, motivatsiya, sport*. Tom 25, S, NSAPRES// Донева, В., Домусчиева-Роглева, Г., Янчева, М. (2021). Лидерски стил и мотивационен климат при спортисти. В: *Личност, мотивация, спорт*. Том 25, С, НСА ПРЕС.

Deci, E., & Ryan, R. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior.* Berlin: Springer Science & Business Media.

Duda, J. L., & Balaguer, I. (2007). Coach-Created Motivational Climate. In S. Jowette & D. Lavallee (Eds.), Social Psychology in Sport, Human Kinetics. pp. 117–130.

Fenerova, D., Tosheva, I., Georgiev, M. (2011). Adaptatsiya na testa za otsenka na liderskiya stil v sporta – *LSS (Chelladurai and Saleh, 1980). Lichnost, motivatsiya, sport.* Tom 16, Sofiya, NSA PRES // Фенерова, Д., Тошева, И., Георгиев, М. (2011). Адаптация на теста за оценка на лидерския стил в спорта – LSS (Chelladurai and Saleh, 1980). *Личност, мотивация, спорт*. Том 16, София, НСА ПРЕС.

Newton, M.L., Duda, J.L., & Yin, Z. (2000). Examination of the psychometric properties of the Perceived Motivational Climate in Sport Questionnaire2 in a sample of female's athletes. *Journal of Sport Sciences*, 18, 275–290

Ryan, R & Deci, E. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being Richard. January 2000. *American Psychologist*. Copyright2000 by the American Psychological Association,Inc. Vol. 55, No. 1, 68-78

The Sport Climate Questionnaire (SCQ). (n.d.). Retrieved October 8, 2022, from https://selfdeterminationtheory.org/sport-climate-questionnaire/

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STUDYING SELF-REGULATION AMONG KARATE COMPETITORS

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ABSTRACT
The efficiency of Karate athletes' actions in competitions depends on the condition of their pre-trained psychological, physical and technical, and tactical readiness. The psychological readiness is in the lead of this process as it determines the activities and the abilities for practical realization of specific motions and actions that lead to achieving an advantage over the opponent. Self-regulation is of great importance in this process since it relates to the ability of the Karate athlete to manage their actions during a competition based on the basis of their operational optimization of athletes' mental readiness. This is the core assumption used in the study, as it relates to studying the self-regulation of Karate competitors. To achieve the objectives of the study, we used a Self Regulation Questionnaire, which allows to determine self-regulation through assessing the emotional, behavioral, and cognitive regulation. The results show that the studied karate athletes have high levels of self-regulation, with some variations according to the level of qualification and their realization in sports. In comparison with the self-regulation among team-sports competitors, karate athletes display much-better abilities to manage their behaviors, emotions, and thinking.
The results of the study provide an idea of the ability of the test participants to effectively realize their technical and tactical actions in a competition. In the pre-competition period, it is necessary to pay attention to the Karate athletes who have lower levels of self-regulation.

Keywords: *regulation, karate athletes, behavior, emotions, thinking*

INTRODUCTION

Karate is among the most commonly practiced martial arts. It is a specific form of physical activity, in which the focus of training falls on the self-development and self-regulation of trainees on their way to the successful realization and the achievement of high sports results. (Potoczny, Herzog-Krzywoszanska, Krzywoszanski, 2022).

The essence of sports preparation in karate, which is characterized by highly efficient moves during competition time, depends on the condition of their previously formed psychological, physical and technical-tactical readiness. Psychological readiness is the leading one, as it controls all activities and predetermined the possibilities for the practical realization of the specific movements and actions, which brings about the supremacy over the opponent. The self-regulation of psychological qualities is of key importance since it is the foundation of competitive behavior, whose adequacy provides the optimal balance between the demands of the situation and the activity specifics of the athlete's performance (Iancheva, 2020).

During competition time, according to the structure of Asian martial arts, it is needed to localize between 12 and 50 elements. It has been estimated that the minimum reaction time of the brain is 0,745 seconds, which cannot be reduced even by intensive training (Madanski, 2013). Therefore, self-regulation, as the ultimate manifestation of conscience, reflects the ability to control the activity of the karate athlete during the competition on the basis of operational optimization of the athlete's psychological preparedness (Kaykov, 1998). In this way, self-regulation as part of the psychological preparation provides the opportunity for the competitor to explore the situation for himself, to program his or her activities, and adjust their own results. (Bondarchuk, Potapov, 2006). Considering this, psychological preparation before, during, and after competitions appears to be operational and is viewed as psychological self-regulation, which implies taking "a complex of measures that lead to the formation of the psychological condition of the athlete, which leads to a maximum realization of his or her potential" (Rodionov, 2010).

According to T. Iancheva (2020), self-regulation of psychological conditions is realized at three levels: sensory-motoric, intellectual, and

behavioral, as direction of thought, emotional and behavioral control, and the athlete's activity of will are extremely important. Other authors state that self-regulation is presented in the individual's capability to change his or her behavior, which provides for flexibility and adaptivity and for the ability to correct the individual's reaction to the changing circumstances of the environment (Baumeister, Voh, 2007). In this respect, only preparation that develops the skill of the athlete to rely only on himself/herself and not feel dependent on others when facing difficulty can be considered efficient, which means that the athlete should be able to apply self-control to the external and internal factors defining the adequacy and the efficiency of his or her actions. This correlation has been observed in a series of scientific studies (Ilchev, 2010; Dimitrov, 2011), as in the area of martial arts after a three-month experiment, positive changes in the cognitive, behavioral, and emotional self-regulation can be observed among practitioners, (Lakes, Hoyt, 2004), as well self-regulation is considered a key factor for success in Taekwon-do competitions (Shagivaleeva, Biserova, Lydokova, 2020).

A theoretical study on the topic shows that the self-regulation of the psychological state of the athletes is of key importance for the outcome of a competition. Regardless of this fact, it hasn't yet been studied with regard to martial arts and in particular regarding Karate. This provokes us to conduct the present study.

Aim and objectives of the study

The aim of the study is to study self-regulation among competitors of Karate. In order to achieve this aim, we set the following *objectives*:

1. Develop the theoretical foundations of the study problem
2. Studying the self-regulation among Karate competitors
3. Analyzing the specifics of the emotional, behavioral, and cognitive self-regulation of the karate competitors studied.

The object of the study are the condition and the specifics of the emotional, behavioral and cognitive self-regulation of the karate competitors studied.

A total of 28 karate practitioners aged 14-16 from Sports Club Fighters, Sofia were studied. They were developed into two groups: 1) Group A, consisting of 11 karate competitors who regularly earn medals; 2) Group B, consisting of 17 regular practitioners of Karate. Additionally, Group C was formed from 18 basketball players aged 15-16 who were tested a single time.

METHODS

In order to achieve our goal, we applied a Self Regulation Questionnaire, through which we assessed the self-regulation of the emotional, behavioral and cognitive regulation. The questionnaire included 13 items. The subjects of the study were asked to express the frequency of manifestation on a scale from 1 (never) to 4 (always). The questionnaire contains three sub-scales defining the emotional, behavioral, and cognitive regulation respectively (Bandy, Moore, 2010). The direction of growth of the results for the emotional and behavioral regulation is negative „-", and for the cognitive regulation is positive „+". All participants studied have signed an informed agreement that the information received from the tests will be used in the present survey.

The information received was processed by means of mathematical-statistical methods by applying the 1) Variational analysis (in order to calculate the average value – $\overline{X}$, and the standard deviation – S) and 2) Hypothesis check for non-parametric data by applying the U criterion of Mann–Whitney (Gigova, 2019).

RESULTS

Credibility of the differences between the students that participated in the first and in the second groups regarding the motivating factors (independent samples) - U-criterion of Mann–Whitney.

After the mathematical and statistical processing of the results from the survey, some correlations regarding the ability of self-regulation among the participants studied were observed. The karate athletes who had achievements at competitions demonstrated much higher levels of emotional and behavioral regulation in comparison with those that practice the sport but do not have high achievements yet. (Table 1).

Table 1. *Statistical significance of the differences between the groups of karate athletes studied*

№	indicators	Group „A“ Medalists		Group „B“ practitioners		d	Z_{emp}	α	P%
	test	$\overline{X}_1$	s	$\overline{X}_2$	s				
1	Emotional regulation	3.6	0.50	4.3	0.50	0.7	2.717	.007	99.3
2	Behavioral regulation	5.8	0.72	6.9	0.67	1.1	3.340	.001	99.9
3	Cognitive regulation	7.3	0.60	7.0	0.68	0.3	1.163	.245	75.5

Among the medalists, the average value of the emotional regulation indicator is 3,6 points with (S = 0,50). This value is 0,7 points lower than the average value of the those who simply practice karate. The calculated value of the warranty probability of the difference is P = 99,3% (Z_{emp} = 2,717). This is completely logical, especially when the sports experience of the survey participants is considered: it is 6.5 years on average for the medalists and 4 years on average for those who only practice. Karate competitions put competitors in an environment that requires them to take efficient actions regardless of the progressively growing fatigue and the effects of various emotional experiences. It is especially the control over emotions that are expressed through the experiences that is the key to success in competitions. These emotions define the adaptations of the karate athlete to the environment and create the conditions for the high activity and efficiency of his or her actions. The domination of positive emotions improves the functionality of the body and the athlete is capable of coping with the challenges of a competition more adequately. For these levels of emotional regulation among medalists, the main role is attributed to the experience gained in the process of training and competitions through the years. The fact that medalists have gone through more difficulties has led to building sustainable will qualities such as decisiveness, persistence, discipline, and confidence. It is the confidence in their own strengths that gives them the opportunity to better control their emotions and adequately construct their behavior in accordance with the requirements of the sports competition. They are better focused and their expectations of success in the competition are a lot more realistic. This can be clearly seen from the observed levels of the indicator for behavioral regulation. The average value amond medalists is 5,8 points (S = 0,72), and among practitioners it is – 6,9 points (S = 0,67). The calculated difference of 1,1 points is significant (P = 99,9%) and is to the benefit of the medalists. Their behavior demonstrates higher capabilities for adequate reactions and actions during a competition, which in turn is a precondition for more successful realization.

Regarding the indicator of cognitive regulation, we did not observe significant differences between the two groups of karate athletes studied. The average levels among the medalists are of 7,3 points (S = 0,60), and for practitioners they are 7,0 points (S = 0,68). The difference of 0,3 points is not credible (P = 75,5%).

In order to estimate the capabilities of self-regulation of karate athletes, we tested a group of basketball players. The average experience of the basketball players in sports is 5 years. The results from the comparative study are presented in Table 2.

It is obvious that the statistical significance of the differences between the karate medalists studied and the basketball players is almost identical to the one observed between karate medalists and karate practitioners.

Table 2. *Statistical significance of the differences between karate medalists and basketball players.*

№	indicators	Group „A“ medalists		group „C“ basketball players		d	Z_{emp}	α	P%
	test	$\overline{X}_1$	s	$\overline{X}_2$	s				
1	Emotional regulation	3.6	0.50	4.1	0.55	0.5	2.139	.032	96.8
2	Behavioral regulation	5.8	0.72	6.8	0.83	1.0	2.857	.004	99.6
3	Cognitive regulation	7.3	0.60	6.9	0.83	0.4	1.398	.162	83.8

The average value of emotional regulation among medalists shows a difference of 0,5 points lower than the one of the basketball players. This is supported by P = 96,8% (Z_{emp} = 2,139). We can confidently confirm that the developed ability to control emotions is inherent to the karate athletes who have achieved success in sports competitions They display high degrees of confidence in their own capabilities, they perform efficient actions and achieve the goals they have set. Our observations support this statement. The good quality of emotional regulation defines to a great extent the psychological condition of medalists and this influences their behavior during the competition time. The average level of behavioral regulation among karate medalists observed is one of 5,8 points (S = 0,72) which is a 1-point difference in comparison with the average result of the basketball players, which is 6,8 points (S = 0,83). This difference is credible and is supported by P = 99,6% (Z_{emp} = 2,857). The etiquette of karate training imposes obeying strict discipline in all of its aspects. This benefits the preparedness of competitors and their capabilities to realize effectively their capabilities in a competition.

Regarding the level of psychological level development, which is part of the cognitive structure of the competitors studied, we observed credible differences. In this regard, it is worth noting that the separate psychological processes that regulate the actions and the behavior of the subjects studied function at approximately the same level. This shows the difference in the average values of cognitive regulations, which is 0,4 points and has a quotient of warranty probability of P = 83,8% (Table 2).

The next comparison shows the self-regulation indicators between karate practitioners and basketball players. The results are presented in Table 3.

Due to the process of competition preparation and along the way of achieving high sports results, both groups studied have almost identical levels of self-regulation. This conclusion can be drawn due to the lack of credible differences in the emotional, behavioral and cognitive regulation.

Table 3. *Statistical significance of the differences between the karate practitioners and the basketball players studied.*

№	indicators	Group „B“ Practitioners		Group „C“ Basketball players		d	Z_{emp}	α	P%
	test	$\overline{X}_1$	s	$\overline{X}_2$	s				
1	Emotional regulation	4.3	0.50	4.1	0.55	0.2	0.678	.498	50.2
2	Behavioral regulation	6.9	0.67	6.8	0.83	0.1	0.690	.490	51.0
3	Cognitive regulation	7.0	0.68	6.9	0.83	0.1	0.334	.739	26.1

The difference in the indicator of emotional regulation is an average of 0,2 points (P = 50,2%). For the behavioral regulation, the difference between the two groups is 0,1 points (P = 51,0%) and for the cognitive regulation, it is also an average of 0,1 points (P = 26,1%). In order to achieve high results, which are characteristic of the karate medalists, regular karate practitioners and basketball players need to put more effort into their training. In addition, it would be beneficial to apply well-established practical methods for psychological regulation such as shifting conscience, forming imagination, optimistic syllogism, verbal suggestion, breathing regulation, etc. Thus, these athletes could activate their cognitive, behavioral, and emotional reactions and more efficiently achieve their goals

DISCUSSION

The results show that the karate athletes studied have high levels of self-regulation, with certain differences resulting from the level of qualification and their realization in sports. The abilities of self-regulation among medalists is defined to a large extent by their emotional and behavioral regulation.

In comparison with the basketball competitors in terms of their self-regulation, karate medalists possess much better capabilities to manage their behavior, emotions, and actions. This supports the claim about the efficiency of karate training, which significantly improves the discipline and the self-control of the trainees. (Messaoud, 2015).

The results of the survey illustrate the capabilities of the participants to effectively realize their technical-tactical actions during competition time. The condition of the specific self-regulation indicators demand the inclusion of well-established methods of psychological regulation in the training process (Kaykov, 1989, 1998). Special attention, during the preparation period, should be given to karate practitioners who posses lower levels of self-regulation.

REFERENCES

Bandy, T., Moore, K. (2010). Assessing self-regulation: a guide for out-of-school time program practitioners. Child Trends. May be reprinted with citation. Washington.

Baumeister, R., Voh, K. (2007). Self-Regulation, Ego Depletion, and Motivation, *Social and Personality Psychology*, Compass 1:10. p. 115–128

Bondarchuk, T., Potapov, V. (2006). Samoregulyatsia psihicheskogo sostoyania sportsmenov vыsshey kvalifikatsii. *Teoria i praktika fizicheskoy kulyturы*, Moskva, N 2, s. 39.// Бондарчук, Т., Потапов, В. (2006). Саморегуляция психического состояния спортсменов высшей квалификации. Теория *и* практика физической культуры*,* Москва*,* N 2, с. 39.

Dimitrov, V. (2011). Psihologicheska samoregulatsia na sastezateli po fehtovka. *Sport i nauka*, Sofia. Izvanr. br.1, s.39-47.// Димитров, В. (2011). Психологическа саморегулация на състезатели по фехтовка. Спорт *и* наука, София. Извънр. бр.1, с.39-47.

Gigova, V. (2019). *Statisticheski metodi s SPSS Statistics: Rakovodstvo za studenti ot OKS "Magistar" i ONS "Doktor" na NSA "Vasil Levski"*. NSA PRES, Sofia.// Гигова, В. (2019). Статистически методи *с SPSS Statistics:* Ръководство за студенти от ОКС «Магистър*" и ОНС "*Доктор*"* на НСА «Васил Левски*"*. НСА ПРЕС, София.

Iancheva, T. (2020). *Psihologichesko osiguryavane v elitnia sport*. NSA PRES, Sofia.// Янчева, Т. (2020). Психологическо осигуряване *в* елитния спорт. НСА ПРЕС, София.

Ilchev, I. (2010). Samoregulatsiyata na dvigatelnite deystvia, kato predpostavka za usavarshenstvane na nachalnata sportnata podgotovka na podrastvashti badmintonisti. *Nauchni trudove na rusenskia universitet*, tom 49, seria 8.2. s. 134-136.// Илчев, И. (2010). Саморегулацията на двигателните действия, като предпоставка за усъвършенстване на началната спортната подготовка на подрастващи бадминтонисти. Научни трудове на русенския университет, том 49, серия 8.2. с. 134-136

Kaykov, D. (1989). *Psihicheskata samoregulatsia i regulatsia pri blizak boy*. Voenno izdatelstvo. Sofia.// Кайков, Д. (1989). Психическата саморегулация *и* регулация при близък бой. Военно издателство. София.

Kaykov, D. (1998). *Kompleksni metodi za psihichna regulatsia i vazdeystvie*. Psiho-fizicheska relaksatsia. „Propeler", Sofia.// Кайков, Д. (1998). Комплексни методи за психична регулация *и* въздействие. Психофизическа релаксация. „Пропелер", София.

Kaykov, D. (1998). *Monostrukturni metodi za psihichna regulatsia i vazdeystvia*. „Propeler", Sofia.// Кайков, Д. (1998). Моноструктурни методи за психична регулация *и* въздействия. „Пропелер", София.

Lakes, J., K., Hoyt, W. (2004). Promoting self-regulation through school-based martial arts training, *Journal of Applied Developmental Psychology* 25(3):283-302

Madanski, V. (2013). *Otselyavane v ekstremalni sit-*

uatsii na voennoprofesiona deynost. Izdatelski kompleks pri NVU "V. Levski", V. Tarnovo.// Мадански, В. (2013). Оцеляване *в* екстремални ситуации на военнопрофесиона дейност. Издателски комплекс при НВУ "В. Левски", В. Търново.

Messaoud, W. (2015). Social representations of karate among young people. Ido movement for culture. *Journal of Martial Arts Anthropology*. 15, 39–48. doi: 10.14589/ido.15.4.6

Potoczny, W., Herzog-Krzywoszanska, R., Krzywoszanski, L. (2022). Self-Control and Emotion Regulation Mediate the Impact of Karate Training on Satisfaction With Life. // *Published online*, Jan 13. doi: 10.3389/fnbeh.2021.802564.

Rodionov, A. (2010). *Psihologia na fizicheskoto vazpitanie i sporta*. Moskva.// Родионов, А. (2010). Психология на физическото възпитание *и* спорта. Москва.

Shagivaleeva, G., Biserova, G., Lydokova, G. (2020). Volevaya samoregulyatsia lichnosti kak faktor dostizhenia uspeha v sorevnovatelynoy deyatelynosti thekvondistov. *Teoria i praktika fizicheskoy kulyturы*, Moskva, XCVI, N 6, s. 32-34.// Шагивалеева, Г., Бисерова, Г., Льдокова, Г. (2020). Волевая саморегуляция личности как фактор достижения успеха в соревновательной деятельности тхеквондистов. Теория *и* практика физической культуры, Москва, XCVI, N 6, с. 32-34.

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THE INFLUENCE OF GENDER ON COACHING EFFICACY AND LEADERSHIP STYLE AMONG BULGARIAN FOOTBALL PLAYERS

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ABSTRACT
According to a number of authors, athletes 'perceptions and evaluations of their coach's effectiveness and behavior (real and preferred) influence athletes' behavior and performance.
The aim of the present study is to examine coaching efficacy expectations and leadership style among Bulgarian football players.
Methods: The research was done among 73 football players (female-28, male-45) aged between 16 and 26 years. In order to fulfill the aim, we used: 1) Coaching Efficacy Scale (CES), Feltz et al., 1999; 2) Revised Leadership Scale for Sport (RLSS), Zhang et. el., 1997.
Results and discussion: The results from the variation analysis showed similar levels in some of the components of coaching efficacy and leadership style. The comparative analysis revealed significant differences depending on the gender of the game strategy subscales and the way the coach makes decisions. There are established significant differences in the preferred behavior of the coach from the players on the social support and positive feedback subscales.
The correlation analysis did not reveal strong relationships between the coaching efficacy subscales and the leadership style subscales. Accordingly, our results differ from the data published in the literature. The results from the regression analysis reveal that coaching efficacy does not directly affect the subscales of the leadership style, which differs from what is reported in the literature.

Keywords: *Coaching Efficacy, Leadership style, Coaching behavior, Gender Differences*

INTRODUCTION

Based on Bandura's (1977, 1994) self-efficacy theory, Feltz, Chase, Moritz, and Sullivan (1999) developed a sport-oriented model of coaching efficacy expectations. The authors defined coaching efficacy expectations as *"the degree to which coaches believe they have the capacity to influence their athletes' training and performance"* (Fltz et al., 1999).

The conceptual model of coaching efficacy consists of three major components: (1) the sources of coaching efficacy information, (2) the dimensions of coaching efficacy, and (3) the outcomes of coaching efficacy. The authors point out that coaching efficacy is an important variable in coaching effectiveness and athletic performance. Feltz and colleagues developed the Coaching Efficacy Scale (CES) to assess coaching efficacy levels on four dimensions - Game strategy efficacy, Motivation efficacy, Technique efficacy, and Character building efficacy (Fltz et al., 1999).

The influence of athletes' perceptions on coaching efficacy in the coaching context has highlighted its importance in a lot of studies (Boardley et al., 2008; Horn, 2002; Kavussanu et al., 2008; Horn, 2002, 2008) formulated a working model of coaching effectiveness which outlines interactions between outside influences, coach attitudes and behavior, athlete attitudes and behavior and sporting performance (Horn, 2002, 2008).

Research on the sources of coaching efficacy found that the coaching experience and the coach's experience as a player could affect development (Feltz et al., 2006; Sullivan et al., 2006). Horn (2002) points out that the gender of the coach and athletes may influence athletes' perceptions of coaching behaviors (Horn, 2002). Short et al. (2005) reported that male coaches demonstrated higher levels of coaching efficacy than women (Short et al., 2006).

Surveys by Weller (2013) on coaches' level of education and gender as predictors of their coaching efficacy revealed substantial differences in the subscales of coaching efficacy only when the interaction between gender and educational level was discussed. Female coaches had significantly lower levels of play strategy than male coaches with the same academic level. Weller added that these data could be used to create or modify training programs for women (Weller, 2013).

Horn (2002) proposed that athletes' perception and interpretation of their coach's behavior influenced their perception of their own beliefs (Horn, 2002). On the other hand, effective leadership was described as a function of behavioral characteristics of the people having some kind of interaction, i.e., the coach and the athletes, and a function of the situation (Chelladurai & Carron, 1978).

In many surveys based on the model of coaching effectiveness among coaches from different kinds of sports (Hwang et al., 2013; Teques et al., 2019) established a direct relation between coaching Efficacy and leadership Style.
Chelladurai (1978) developed a Multidimensional leadership model including three kinds of leader behavior: obligatory, preferable, and actual. The author pointed out that the leader would be more efficient if the team's satisfaction with the leader was high. According to the model, the efficiency of leadership is a product of the proper interactions between the leader's characteristics (e.g., interpersonal skills, experience, and decision taking), the athletes' characteristics (e.g., age, gender, level of skills, experience, and motivation), and the context (e.g., the group size, the kind of sport, and the significance of the competition/game) (Chelladurai, 2007).

Keatlholetswe and Malete (2019) established relationships between coaches' self-ratings on coaching efficacy and athletes' perception of leadership Style. The subscale technique efficacy predicted player perceptions of the coaches' use of all six leadership styles, while character-building efficacy was negatively associated with the various leadership styles. In another research, Li et al. (2019) found that all subscales of Coaching Efficacy were positively related to those of Leadership Style, except for AB.
Cumming et al. (2006) found close values of the subscales of Leadership Style according to competitors' gender (Cumming et al., 2006). Another survey by Ignacio et al. (2017) on competitors' perceptions and coaches' behavior revealed that the coaches of male athletes used a more democratic behavior than the coaches of female athletes (Ignacio et al., 2017).
According to the multidimensional leadership model, the coach is most effective when their behaviors match behaviors preferred by the athletes (Chelladurai & Saleh, 1978).

Chelladurai's Model proposes that the gender of the athlete is a contributing factor to athlete preferences for coaching behavior and also affects the required behavior of the coach.

Windsor (2005) found collegiate female soccer players preferred a more democratic style, where the coach encourages athlete involvement, provides positive feedback for behavior, and encourages and makes corrections for athletes after mistakes. These data confirmed those obtained by Chelladurai and Saleh (1978) and Sherman et al. (2000) that male athletes prefer more Autocratic and Social Support Behavior, and female athletes prefer more Democratic Behavior and positive feedback (Chelladurai & Saleh, 1978; Sherman et al., 2000).

A survey by Turner (2021) among 509 female volleyball players found that women preferred training and instruction behaviors and situational consideration, and the least - Autocratic Behavior.
The aim of this study was to examine athletes' perceptions of coaching efficacy and leadership styles, athletes' preferences of coaching behavior, and the influence of gender on them.

METHOD

Participants

The research was done among 73 football players – 28 females aged between 16 and 26 years (M=18.54, SD=3.59) and 45 males aged between 13 and 18 years (M=15.67, SD=1.72). At the beginning of the research, all participants were informed about the survey's aim and agreed to participate.

Measures

In order to fulfill the aim of the research, we used:

Background information.
Coaching Efficacy Scale (CES; Feltz et al., 1999), adapted for Bulgarian conditions by T. Iancheva, 2012. The CES - 24 items (where items are rated on a 10-point scale). It includes four subscales: *Motivation efficacy*, *Game strategy efficacy*, *Character building efficacy,* and *Teaching technique efficacy*.

Revised Leadership Scale for Sport (RLSS; Zhang et. el., 1997). The six-factor structure of leadership behaviors is represented through 60 items that are measured using a 5-point Likert-type scale - *Democratic behavior*, *Positive feedback behavior, Situation consideration behavior, Teaching and instruction behavior, Social support behavior,* and

Autocratic behavior. We first used (My coach…) and then (I prefer my coach…) version of the questionnaire.

Statistical methods

When processing the initial data from the research, we used the statistical package SPSS 21 and made variation, correlation, comparative, and regression analyses.

RESULTS AND ANALYSIS

The results from the variation analysis (Figure 1) for perceptions of coaching efficacy of the players showed that the subscale motivation efficacy had the highest values both for men and women. The men had the lowest values for game strategy efficacy, the coach's confidence to create a correct strategy for a match, and to take critical decisions during the game. The obtained results confirmed the results from our previous surveys among Bulgarian football coaches (Iancheva & Prodanov, 2018, 2019). The women had the lowest values for the subscales character building efficacy and teaching technique efficacy.

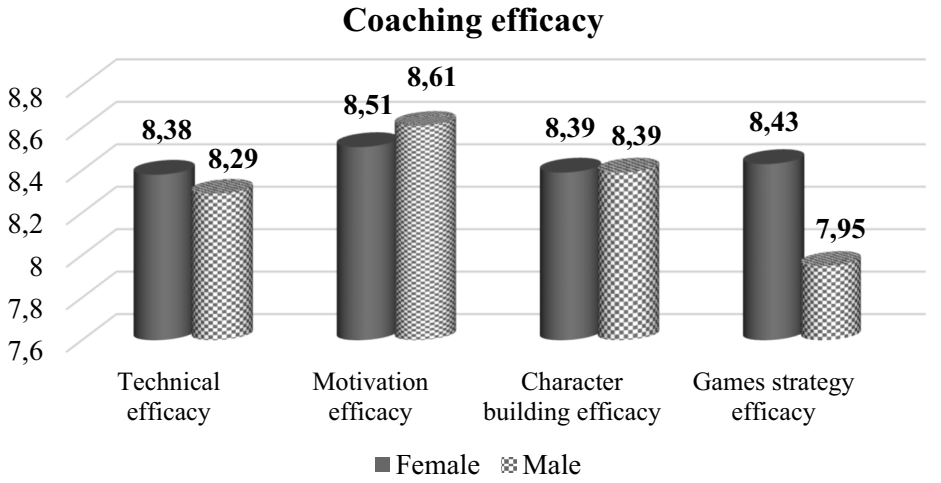

Figure 1. *Players' Perceptions of coaching efficacy*

The results showed (Figure 2) that the highest values were observed in Training and instruction behavior, related to giving instructions and corrections for the team's performance in training and competitions. These were followed by Situational consideration behavior, considering the possibilities and load regulation. The results revealed that the coaches of football players had a greater willingness to take decisions democratically.

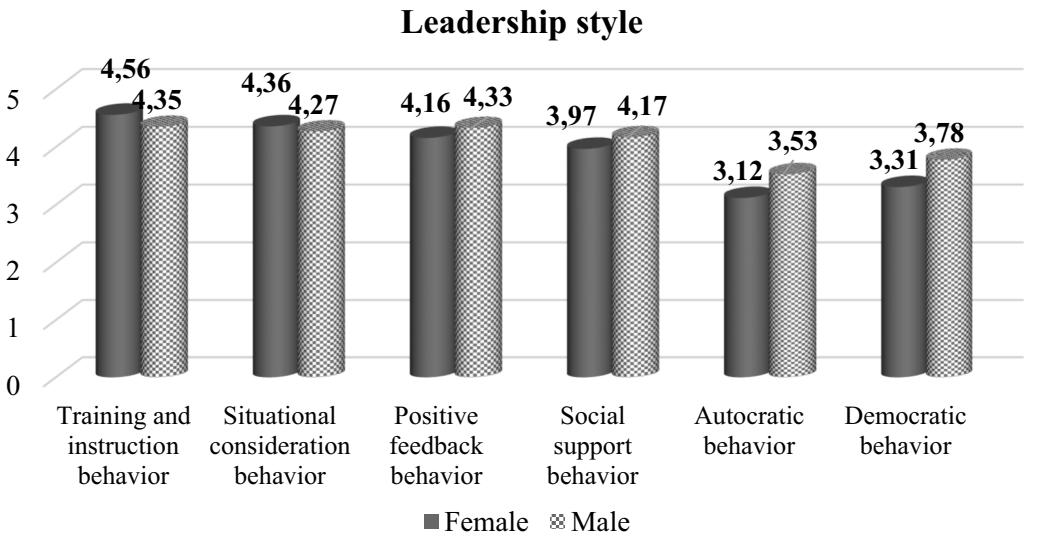

Figure 2. *Players' perceptions of coaches' leadership styles*

Figure 3 shows players' preferences of coaches' leadership styles. The results for both groups were close.

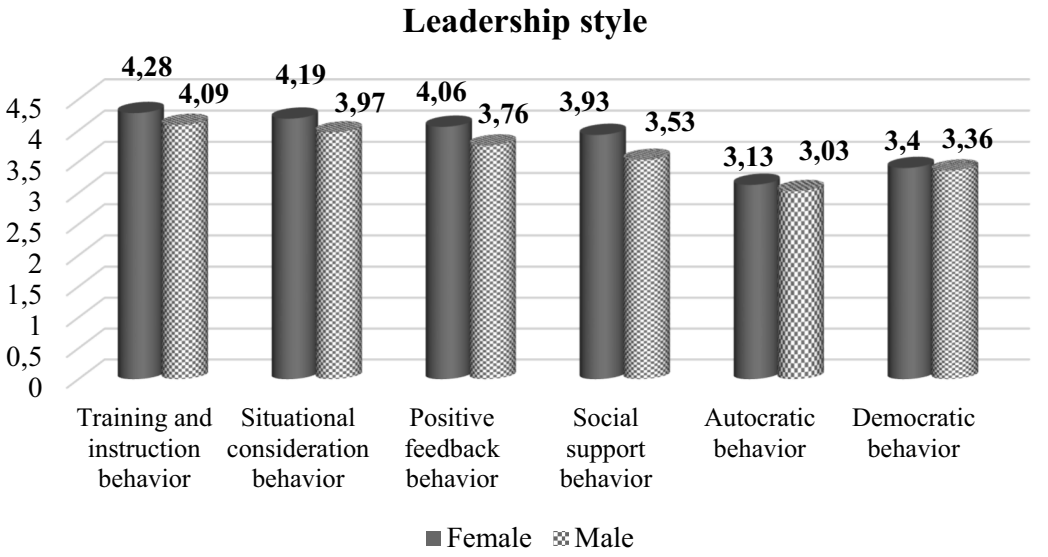

Figure 3. *Players' preferences of coaches' leadership styles*

The comparative analysis of the data revealed statistically significant differences according to the gender of the players (Figure 4) in three of the subscales. The women had significantly higher values in the subscale games strategy efficacy; they preferred that the coach express more social support behavior and positive feedback behavior than men.

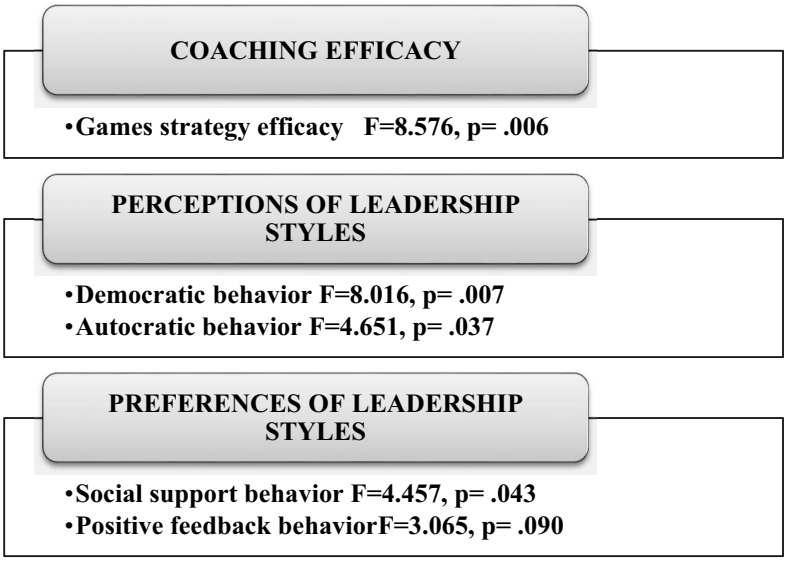

Figure 4. *Comparative analysis of female and male players*

The results from the step regression analysis of men revealed that *Motivation efficacy*, stimulate *Situation consideration behavior* (β = .759***), *Democratic behavior* (β = .765**), *Social support behavior* (β = .669**), *Positive feedback behavior* (β = .629*) and *Teaching and instruction behavior* (β = .604*), while *Game strategy efficacy* influences *Autocratic behavior* (β = .553 *).

There were no significant regression dependencies between the subscales of Coaching Efficacy and Leadership Style among the women.

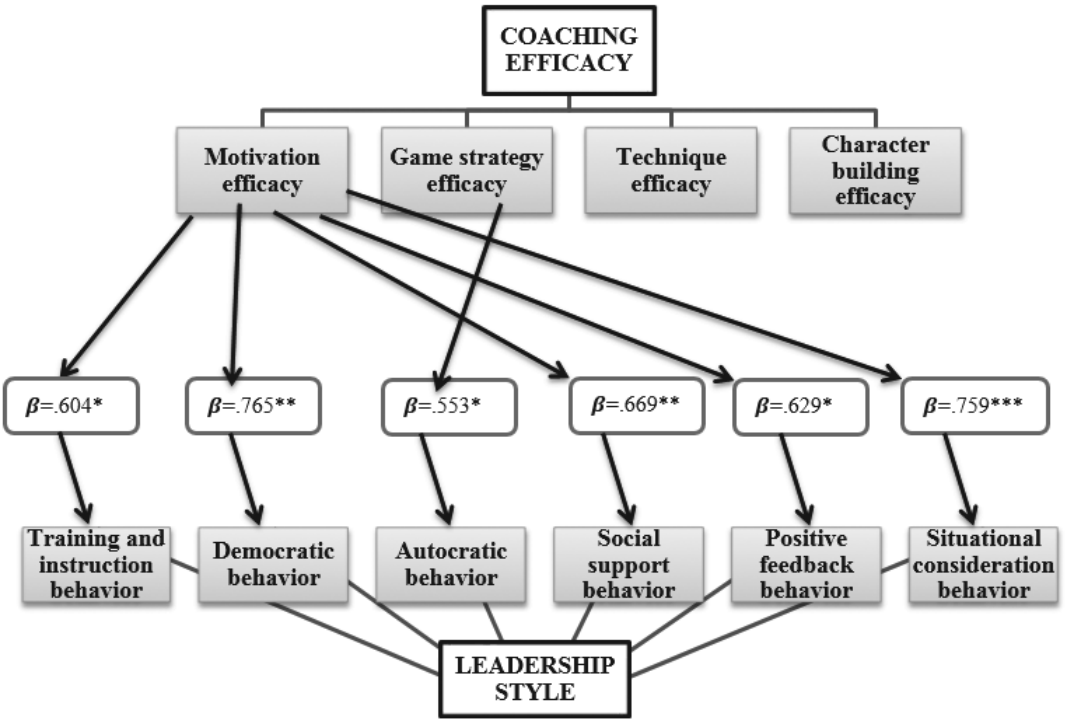

Figure 5. *Results from Regression analysis*

DISCUSSION

The obtained results revealed that coaches' confidence affects competitors' activity and motivation and is evaluated the most by the players from both genders. These results are similar to those from our previous studies with football coaches (Iancheva, Prodanov, 2018, 2019). Still, they differ from those of Kavussanu et al. (2008), who found the lowest values for motivation efficacy. These results contradict the public appearance of some coaches, who explain losses with a lack of motivation. The results reveal the lowest values in the subscale game strategy efficacy for the men. These data confirm the results from our previous studies with male football coaches (Iancheva, Prodanov, 2018, 2019) and are similar to those obtained by Li et al. (2019). The subscale technical efficacy was with the lowest values for the women.

The results from our research show that the coaches of female and male players very often have behavior related to providing instructions and corrections for the team's performance in training and competition (Training and instruction behavior) and consider their possibilities when regulating the load (Situational consideration behavior). The coaches of male players tend to make decisions more democratically. These data confirm the ones obtained by Ignacio et al. (2017). He reported that male athletes used a more democratic behavior than female athletes (Ignacio et al., 2017).

Women and men's preferences for coaching behavior are similar. They want the coach to show more training and instruction, situational consideration, and positive feedback behavior. Our data confirm those of Turner (2021), Cruz and Kim (2017), and Sullah et al. (2014). Football players prefer Social support behavior the least, i.e., when the coach gives them advice about their personal lives and talks with them outside the pitch about anything. The obtained results for the men differ from those obtained by Chelladurai and Saleh (1978) and Sherman et al. (2000), where the men preferred Social support behavior more. The players prefer Democratic Behavior to Autocratic Behavior. Our data coincide with the ones obtained by Windsor (2005) with female football players and the results of Martin et al. (1999).

From the conceptual point of view, the expectations for coaching efficacy are considered a cognitive mediator between resources and results. A large body of studies (Horn, 2002; Hwang et al., 2013; Teques et el., 2019; Kavussanu et al., 2008; Myers et al., 2005; Sullivan & Kent, 2003; Sullivan et al., 2012; Li et al., 2019) based on the model of Feltz et al. (1999) and that of Horn (2002), present empirical proof that as a personality attribute, Coaching efficacy is a strong predictor of Leadership Style. Our results differ from those in the specialized literature. The correlation analysis revealed weak connections between the subscales of Coaching

Efficacy and those of Leadership Style. Li et al. (2019) established strong positive relations, except for autocratic behavior. The regression analysis of the data found that the subscale motivation efficacy stimulates all the scales of Leadership Style, except for autocratic behavior; a game strategy efficacy influences autocratic behavior. There were no dependencies found for the researched women.

LIMITATIONS

We should point out some limitations of our research. It was conducted among girls and boys, training football. Future surveys with a larger number of players from different kinds of sports and of various ages could shed more light on this important for theory and practice issue.

REFERENCES

Bandura, A. (1977). Self-Efficacy: Toward a unifying theory of behavioral change, *Psychological Review*.

Bandura, A. (1994). Self-efficacy. *Encyclopedia of human behavior*. Vol. 4, pp. 71-81.

Boardley, I. D., Kavussanu, M., & Ring, C. M. (2008). Athletes' perceptions of coaching effectiveness and athlete-related outcomes in rugby union: an investigation based on the coaching efficacy model. *Sport Psychologist* 22, 269–287.

Chelladurai, P. & Carron, A. V. (1978). *Leadership.* Cahper, Sociology of Sports Monograph Series. Calgary, Alberta, Canada: University of Calgary.

Chelladurai, P. & Saleh, S.D. (1978). Preferred leadership in sports. *Canadian Journal of Applied Sport Sciences* 3, 85-92.

Chelladurai, P. (1978). *A contingency model of leadership in athletics.* Unpublished doctoral dissertation, University of Waterloo, Waterloo, Ontario.

Chelladurai, P., & Saleh, S. D. (1980). Dimensions of leader behavior in sports: development of a leadership scale. *Journal of Sport Psychology*, 2, 34-45.

Chelladurai, P. (2007). *Leadership in Sports,* in: Tenenbaum, G. and Eklund, R.C., eds., Handbook of Sport Psychology, 3 Rd edn., John Wiley & Sons, New York, 113-135.

Cruz, A.B. & Kim H.D. (2017). Leadership Preferences of Adolescent Players in Sport: Influence of Coach Gender. *J Sports Sci Med.* Jun 1;16(2):172-179.

Cumming, S., P., Smith, R., E., & Smoll, F., L. (2006). Athlete-Perceived Coaching Behaviors: Relating Two Measurement Traditions. *Journal Of Sport & Exercise Psychology*, 2006, 28, 205–213.

Feltz, D. L., Hepler, T.J., Roman, N., & Paiement, C.A. (2006). Coaching efficacy of youth sport coaches: Extending validity evidence for the Coaching Efficacy Scale. *Unpublished manuscript, Michigan State University, East Landsing.*

Feltz, D., Chase, M., Moritz, S., & Sullivan, P. (1999). A conceptual model of coaching efficacy: Preliminary investigation and instrument development, *Journal of Educational Psychology*, pp. 765–776.

Hastie, P. A. (1993). Coaching preferences of high school girl volleyball players. *Perceptual and Motor Skills*, 77, 1309-1310.

Hastie, P.A. (1995). Factors affecting coaching preferences of secondary school volleyball players. *Perceptual and Motor Skills* 80, 347–350.

Horn, T.S. (*2002*). *Coaching Effectiveness in the Sports Domain.* In Horn, T.S., Ed., Advances in Sport Psychology, Human Kinetics, Champaign, IL, pp. 309–354.

Horn, T.S. (2008). Coaching effectiveness in the sports domain. *In T.S. Horn (Ed.), Advances in sport psychology, 3rd Edition,* Champaign, IL: Human Kinetics, pp. 239–265.

Hwang, S., Feltz, D. L., & Lee, J. D. (2013). Emotional intelligence in coaching: Mediation effect of coaching efficacy on the relationship between emotional intelligence and leadership style. *International Journal of Sport and Exercise Psychology*, 11(3), pp. 292-306.

Iancheva, T., & Prodanov, G. (2018). Influence of Emotional intelligence on coaching efficacy expectations among football coaches. *Journal of Applied Sports Sciences,* Vol. 02, 59-72.

Iancheva, T., & Prodanov, G. (2019). Coaching Efficacy and Leadership style among Bulgarian football coaches. *International Scientific Congress „Applied Sports Sciences*", NSA Press, 242-248.

Ignacio, A., R., R., Montecalbo-Ignacio & R., Cardenas (2017). The Relationship between Perceived Coach Leadership Behaviors and Athletes Satisfaction, *International Journal of Sports Science* 2017, 7(5): 196-202.

Kavussanu, M., Boardley, I. D., Jutkiewicz, N., Vincent, S. and Ring, C. M. (2008). Coaching efficacy and coaching effectiveness: examining their predictors and comparing coaches' and athletes' reports. *The Sport Psychologist* 22, pp. 383-404.

Keatlholetswe, L. & Malete, L. (2019). Coaching Efficacy, Player Perceptions of Coaches' Leadership Styles, and Team Performance in Premier League Soccer. *Research Quarterly for Exercise and Sport*. 90 (1), 71-79.

Li, M.H., Sum R.K.W., Wallhead T., Ha A.S.C., Sit C.H.P., Li R. (2019). Influence of Perceived Physical Literacy on Coaching Efficacy and Leadership Behavior: A Cross-Sectional Study. *Journal of Sports Science and Medicine* (1): pp. 82–90.

Martin, S.B., Jackson, A.W., Richardson, P. A. & Weiller, K.H. (1999). Coaching preferences of adolescent youths and their parents. *Journal of Applied Sport Psychology* 11, 247–262.

Myers, N. D., Vargas-Tonsing, T. M., & Feltz, D. L. (2005). Coaching efficacy in intercollegiate coaches: Sources, coaching behavior and team variables. *Psychology of Sport and Exercise,* 6, pp. 129–143.

Sherman, C. A., Fuller, R., & Speed, H. D. (2000). Gender comparisons of preferred coaching behaviors in Australian sports. *Journal of Sport Behavior*, 23(4), 389–406.

Short, S. E., Smiley, M., & Ross-Stewart, L. (2005). The relationship between efficacy beliefs and imagery used in coaches. *The Sport Psychologist,* 19, 380-394

Sullah, A., Tan, C.H.& Ismail, S. (2014). Preferred Coaches' Leadership Styles of Malaysian Football Teams. In: Adnan, R., Ismail, S., Sulaiman, N. (eds) *Proceedings of the International Colloquium on Sports Science, Exercise, Engineering and Technology, (ICoSSEET, 2014*), 635-639.

Sullivan, P. J., Gee, C. J., & Feltz, D. L. (2006). Playing experience: The content knowledge sources of coaching efficacy beliefs. *In A. V. Vitel (Ed.), Trends in educational psychology. New York, NY: Nova*, pp. 185–194.

Sullivan, P., J. & Kent, A. (2003). Coaching Efficacy as a Predictor of Leadership Style in Intercollegiate Athletics, *Journal of Applied Sport Psychology*, 15:1, pp. 1–11.

Sullivan, P., Paquette, K., Holt, N., & Bloom, G. (2012). The relation of coaching context and coach education to coaching efficacy and perceived leadership behaviors in youth sport. *Sport Psychol.* 26, pp. 122–134.

Teques, P, Duarte, D. and Viana, J. (2019). Coaches' Emotional Intelligence and Reactive Behaviors in Soccer Matches: Mediating Effects of Coach Efficacy Beliefs. Front. Psychol.

Turner, B. (2021). Preferences of Collegiate Volleyball Players Regarding Leadership Style. *Journal of Sport Pedagogy and Research,* 7(6), 4–12.

Weller, G. V. (2013). Youth Sports Coaching Efficacy: Coach Education Level as a Predictor of Coaching Efficacy. *Educational Administration: Theses, Dissertations, and Student Research*. 164.

Windsor, W. J. (2005). *Gender comparisons of preferred coaching behaviors among selected Division I soccer players* (Unpublished doctoral dissertation). United Sports Academy, Dunmore, PA.

Zhang, J., Jensen, B. E., & Mann, B. L. (1997). Modification and revision of the leadership scale for sport. *Journal of Sport Behaviour*, 20, 105–122.

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PSYCHOLOGICAL DETERMINANTS OF BEHAVIOR AND COPING STRATEGIES OF ATHLETES IN CONDITIONS OF PANDEMIC COVID-19

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ABSTRACT
The pandemic COVID 19 and the related restrictions regarding sports activities, social isolation, unclear prospects, and fear of being infected led to an abrupt change in athletes' rhythm of life and the need to adapt.
The aim of this study was to investigate Psychological Capital and Perfectionism as an essential personal resource, their influence on the domineering psychic states, and athletes' preferred coping strategies during the pandemic COVID-19, and to outline their specificity depending on gender, kind of sport, and level of qualification.
The research was done among 119 athletes aged between 18 and 35 years, divided into groups according to their gender (54 men and 65 women), kind of sport, and level of qualification.
The research methods included: 1) Psychological Capital Questionnaire (Luthans, Youssef, Avolio, 2007); 2)Multidih mensional Perfectionism Scale (FMPS, Frost, Marten, Lahart & Rosenblate, 1990), adapted for Bulgarian conditions by T. Iancheva, 2009; 3) Profile of Mood States (McNair, Lorr, & Droppleman, 1971); 4) Approach to Coping in Sport Questionnaire (ACSQ-1; Kim 1999; Kim & Duda, 1997).
There are significant differences depending on gender and the kind of sport. The specific role of adaptive and maladaptive perfectionism and psychological capital was viewed in relation to the dominant psychic conditions during social isolation and the preferred coping strategies.

Keywords: *Psychological Capital, Perfectionism, Mood States, coping strategies, COVID-19*

INTRODUCTION

In the last three years, the world had to face a non-precedential ordeal – the pandemic COVID 19. It affected all spheres of social life – political, economic, and social. The imposed restrictions led to significant changes in people's everyday life. Social isolation, as a consequence of the lockdown, on the one hand, was crucial for preserving people's lives and health. Still, on the other hand, as Brooks et al. (2020) noted, it can significantly influence the psyche (Brooks et al., 2020) and lead to adverse psychological effects – depression, increased anxiety, aggressive reactions, risky behavior, etc.

The sphere of sport was one of the most affected – in sports-technical, management, economic, and psychological aspects. The initial cancellation of the whole sports calendar, including the most significant sports event – the Summer Olympic Games in Tokyo 2020, the restrictions in the training and competitive activities, the subsequent adaptation to the regular sports-competitive activity, the fear of being infected and its consequences affected every link in the chain of sports activities – athletes, teams, sports-technical teams, media, business, and sports education. The physical and psychic consequences in the field of sport related to pandemics have been described in a lot of documents (Association for Applied Sport Psychology; International Society of Sport Psychology: Henriksen et al., 2020).

The analysis of scientific publications in the field of sports psychology shows that they are primarily aimed at the psychological consequences of the pandemic – athletes' behavior in self-isolation (MacIntyre et al., 2020), perception of risk and uncertainty related to the pandemic, the role of social influence, behavior, emotions, stress, overcoming, and wellbeing (Sokolowska, Ayton and Brandstätter, 2020), psychological health (Wang, Wang, Yang, 2020) Van Bavel et al. (2020) paid attention to the necessity of uniting the efforts in studying the consequences of the pandemic on people's behavior. Schinke, Papaioannou, Henriksen, Si, Zhang, & Haberl (2020) emphasized the numerous problems and opportunities of sports psychologists related to sports indicators, physical activity, and health in the conditions of COVID-19. Zhou, K et al. (2020) analyzed people's emotions and coping strategies in pandemics. Other authors (Leguizamo et al., 2020, Iancheva et al., 2020, Iancheva, 2020) analyzed the relation be-

tween perfectionism and anxiety and the indicators of athletes' physical health and coping strategies, the need for support in overcoming the crisis of uncertainty during (Andreato et al., 2020) and after the pandemic – prevention of health problems due to potentially tighter competitive schedule (Rea, 2020).

There are few surveys on psychological determinants of behavior in the conditions of pandemics and crises and the related restrictions. The importance of preparing for such crises is growing as well as the need to develop suitable coping strategies (e.g., a new lockdown, canceled competitions, effects of the international situation, etc.). This made us examine the relationship between psychological capital of a person and perfectionism as behavior determinants, the domineering psychic states as a consequence of the pandemic, and on this basis – the preferred coping strategies.

Psychological capital is an attitude and behavior that significantly determines success (Luthans et al., 2007). This is a state where everyone can practice and have various positive situations that lead to positive attitudes and work behavior. Psychological capital is defined as an individual positive state of development and is characterized with: 1) Self-confidence and self-efficacy to undertake and direct actions needed for success in challenging tasks and situations; 2) Optimism (a positive attribution about succeeding now and in the future); 3) Hope – perseverance in goals and their achievement and redirecting the ways and means of their accomplishment; 4) Flexibility and resiliency needed when people undergo some difficulties and face problems, troubles, and failures to resist and go on to achieve success (Luthans, Youssef, Avolio, 2007; Luthans, Youssef-Morgan, Avolio, 2015, Ilieva, 2019, 2021).

Psychological capital positively impacts individuals' satisfaction, performance, and commitment to organizations (Avey et al., 2011; Luthans et al., 2005; Luthans et al., 2008; Peterson et. al., 2011).

Coping with stress requires high and adaptive coping strategies to maintain the psychological state and efficiency (Gram, Jæger, Liu, Qing, & Wu, 2013; Meneghel, 2014). In the conditions of the pandemic COVID-19, this issue is very significant. Positive reformulation generates positive emotions which help restore psychological resources and motivation needed for perseverance in accomplishing the goals (Folkman, 2008, 2009, 2010; Lazarus, 2006). Riolli et al. (2012) suggested that psychological capital could be related to more positive and less negative cognitive assessments of stress.

Psychological capital is crucial in prolonged crises. The feeling of "loss or lack of control" can decrease self-confidence, enhance the feeling of hopelessness and pessimism, and weaken flexibility, resiliency, and coping possibilities (Luthans, Youssef, Avolio, 2007).

Perfectionism is an essential psychological variable affecting the way an athlete's cognitive, affective, and behavioral characteristics function (Davis, 1997; Frost, Heimberg, Holt, Mattia, & Neubauer, 1993, Hamashek, 1998; Terry-Short, Owens, Slade, & Dewey, 1995). It is defined as a net of cognitions, including expectations, interpretation, and evaluation of events (Burns, 1980), such as "setting unrealistically high standards, accompanied by overcritical self-assessment" (Frost, Marten, Lahart & Rosenblate, 1990). Perfectionism is related to orientation to higher goals and more successful performance (Bradham, 2000). It is connected to setting extremely high standards of performance accompanied by tendencies for a very critical assessment (Flett & Hewitt, 2002; Frost, Marten, Lahart, & Rosenblate, 1990). Perfectionism is determined to be a common characteristic of competitors (Dunn, Gotwals, & Causgrove Dunn, 2005), especially elite athletes (Gould, Dieffenbach, & Moffet, 2002), and to be a predictor of emotional coping in trouble (Curran & Hill, 2019; Egan et al., 2011).

A lot of researchers (Terry-Short, Owens, Slade I Dewey) view perfectionism as a two-dimensional model – positive and negative. Frost, Heimberg, Holt, Mattai, and Neubauer (1993) outlined the differences between adaptive and maladaptive perfectionism. Adaptive perfectionism is viewed as a positive pursuit of achievement, while non-adaptive perfectionism refers to the assessment and is related to fear of failure (Enns, Cox, Sareen, & Freeman, 2001).

From this point of view, studying psychological capital as a positive personal resource, perfectionism, and their relation to the domineering psychic

states and coping strategies in crisis is interesting. We can assume that psychological capital and adaptive perfectionism have a positive correlation and stimulate positive coping strategies in the conditions of the pandemic COVID-19.

The aim of this study was to investigate the Psychological Capital and Perfectionism as an essential personal resource, their influence on the domineering psychic states, athletes' preferred coping strategies during the pandemic COVID-19, and to outline their specificity depending on gender, kind of sport, and level of qualification.

MATERIALS AND METHODS

Participants

The research was done among 119 athletes aged between 18 and 35 years. For the purposes of the research, the participants were divided into groups according to their gender (54 men and 65 women), kind of sport, and level of qualification (competing in: regional competitions, national championships, and international competitions).

The research was held in the period November 2021 – April 2022.
At the beginning of the research, all participants were informed about the aim of the survey, and their consent was obtained.

Instruments

In order to fulfill the aim of the research, we used complex methods, including:
Psychological Capital Questionnaire (Luthans, Youssef, Avolio, 2007) - includes 24 statements divided into four subscales – self-efficacy, optimism, hope, and resiliency.

Multidimensional Perfectionism Scale (FMPS, Frost, Marten, Lahart & Rosenblate, 1990), adapted for Bulgarian conditions by T. Iancheva, 2009. This scale provides six subscales: *Personal Standards, Concern over Mistakes, Parental Expectations, Parental criticism, Doubts about actions, and Organization.*
Profile of Mood States (McNair, Lorr, & Droppleman, 1971) was used in its Spanish adapted and validated version by Fuentes, Balaguer, Meliá and García-Merita (1995). The scale contains 29 items answered on a 5-point scale. The scale reports five moods: *tension, anger, vigor, fatigue, and depression*.

Approach to Coping in Sport Questionnaire (ACSQ-1; Kim 1999; Kim & Duda, 1997) was used in its Spanish version (Kim, Duda, Tomás, & Balaguer, 2003). This scale contains 28 items answered in Likert type from 1 (never) to 5 (always). The five dimensions of coping assessed are: *emotional calming*, *active planning/cognitive restructuring*, *mental withdrawal*, *seeking social support,* and *behavioral risk*.

Statistical Analysis

In order to process the initial data from the research, we used the statistical program SPSS 21. We did an alternative analysis, correlation analysis, comparative analysis (U-criterion of Mann-Whitney and Criterion of Kruskal-Wallis), and step regression analysis.

RESULTS AND ANALYSIS

The results from the descriptive statistics revealed that among the researched athletes hope (M=4.45) as a component of psychological capital had the highest values (Table 1). This outlined favorable expectations about future development related to a belief in the ways to achieve goals, take the initiative, and plan. Hope was followed by self-efficacy (M=4.24) – confidence in own abilities to mobilize cognitive resources, and optimism (M=4.20), related to flexible and realistic prospects for oneself, and an optimistic way of thinking and action. Resiliency had the lowest values (M=4.11) – a person's abilities to cope with difficulties and failures and to set positive changes into motion.

Table 1. *Descriptive statistics of study variables*

	N	Min	Max	M	SD
Self-efficacy	119	2.40	5.00	4.2352	0.59337
Optimism	119	2.30	5.00	4.2000	0.55297
Hope	119	3.20	5.00	4.4495	0.40835
Resiliency	119	1.00	5.00	4.1110	0.58108
Parental criticism	119	1.00	4.00	2.0835	0.62544
Personal standards	119	1.40	5.00	3.6769	0.70239
	119	1.00	4.00	2.2967	0.67683
Organization	119	1.30	5.00	4.2430	0.71118
Parental Expectations	119	1.00	4.30	2.3505	0.70575
Dubs about actions	119	1.00	4.70	2.6000	0.66232
Tension	119	1.00	4.20	2.1718	0.70839
Depression	119	1.00	3.00	1.4941	0.51394
Anger	119	1.00	3.40	1.9047	0.47079
Vigor	119	1.80	4.60	3.2341	0.60780
Fatigue	119	1.00	4.00	1.8882	0.70024
Emotional calming	119	2.00	5.00	3.6385	0.66245
Active planning/cognitive restructuring	119	1.70	5.00	4.0044	0.78059
Mental withdrawal	119	1.00	3.80	1.7945	0.58791
Behavioral risk	119	1.00	4.50	2.1495	0.88724
Seeking social support	119	1.00	5.00	2.4802	1.10144

One of the tasks of our research was to study the relation between perfectionism, domineering psychic states, and coping strategies in crises (in this case, the pandemic COVID-19). The results revealed that among the researched athletes, adaptive perfectionism was domineering (Table 1). The scales Organization (M=4.24) and Personal standards (M=3.68) had the highest values. The lowest values were observed on the scales Parental criticism (M=2.08) and concern over mistakes (M=2.30). The obtained results confirmed the results from our previous studies (Iancheva et al., 2020; Iancheva, 2000)

Active planning, Cognitive restructuring (M=4.00), and Emotional calming (M= 3.64) were dominant in the sample we researched (Table 1). Athletes tried to get the positive out of the situation, to learn something new, and to restructure their goals. They tried to block the negative thoughts, to keep their positive emotional state so that they could counter the problem and concentrate on important things. They showed a weaker proneness to Seeking social support (M=2.48) from their coaches, psychologists, parents, and friends to cope with the problem, and Behavioral risk (M=2.15). Mental withdrawal (M=1.75) received the lowest score - they did not quit trying to achieve their goals, get reconciled with the situation nor did they refuse to be active.

The comparative analysis of the data established significant differences along the researched indicators depending on gender.

Table 2. *Results from the comparative analysis along the factor sex*

	Parental Expectations	Fatigue	Emotional calming	Active planning	Seeking social support
Mann-Whitney U	769.500	673.000	695.000	683.000	597.000
Wilcoxon W	1945.500	1619.000	1641.000	1629.000	1543.000
Z	-2.093	-2.037	-2.687	-2.784	-3.466
Asymp. Sig. (2-tailed)	.036	.042	.007	.005	.001

We found that the women had higher levels of fatigue but significantly higher values of the active coping strategies – emotional calming, active planning, and cognitive restructuring. They were more willing to seek social support on behalf of their coaches, psychologists, and friends to cope with the consequences of the pandemic. The men showed significantly higher values for parental expectations.

Table 3. *Results from the comparative analysis along the factor sport*

	Personal standards	Concern over Mistakes	Vigor	Fatigue	Seeking social support
Chi-Square	27.188	27.861	29.746	38.046	29.482
df	18	18	18	18	18
Asymp. Sig.	.046	.044	.040	.004	.043

There were statistically significant differences along the factor sport in four of the researched indicators – Personal standards, Concern over Mistakes, Vigor, Fatigue, and Seeking social support. Most probably, the specific sports environment and the imposed management style in different sports affect the personal standards and attitude toward mistakes, the domineering psychic states, and seeking support for coping in crises.

We applied a step regression analysis to check our hypothesis about the role of psychological capital and perfectionism as predictors of the domineering psychic states and the preferred coping strategies in crisis (in this case, the pandemic COVID 19).

Table 4. *Results from Regression analysis*

Self-efficacy				
	β	**t**	**Sig.**	**ΔR^2**
Vigor	.451	4.814	.000	.166
Anger	-.303	-3.209	.000	.291
Emotional calming	.287	3.131	.002	.368
Optimism				
		t	**Sig.**	**ΔR^2**
Fatigue	-.385	-4.127	.000	.142
Cognitive restructuring	.336	3.805	.000	.269
Vigor	.270	2.997	.004	.337
Seeking social support	.224	2.435	.017	.382
Hope				
	β	**t**	**Sig.**	**ΔR^2**
Cognitive restructuring	.327	3.156	.002	.107
Resiliency				
	β	**t**	**Sig.**	**ΔR^2**
Depression	-.415	-3.841	.000	.163
Cognitive restructuring	.224	2.380	.002	.215
Vigor	.227	2.287	.025	.254
Fatigue	.221	2.108	.038	.294

The results from the regression analysis (Table 4) confirmed our hypothesis that the components of psychological capital stimulate Vigor and restrict the negative psychic states – Anger, Fatigue, and Depression. They determine the active coping strategies - Cognitive restructuring, Emotional calming, and Seeking social support.

Table 5. *Results from Regression analysis*

Personal standards				
	β	**t**	**Sig.**	**ΔR²**
Emotional calming	.280	2.731	.008	.087
Depression	-.239	-2.337	.022	.144
Organization				
		t	**Sig.**	**ΔR²**
Emotional calming	.360	3.514	.001	.129
Parental criticism				
	β	**t**	**Sig.**	**ΔR²**
Anger	.361	3.578	.001	.115
Mental withdrawal	-.242	-2.404	.018	.173
Concern over Mistakes				
		t	Sig.	ΔR²
Tension	.446	4.542	.000	.199
Parental Expectations				
	β	**t**	**Sig.**	**ΔR²**
Mental withdrawal	-.279	-2.675	.009	.067
Anger	.224	2.147	.035	.116
Dubs about actions				
	β	**t**	**Sig.**	**ΔR²**
Tension	.234	2.191	.031	.055

The results showed that adaptive perfectionism (Personal standards and Organization) stimulates emotional calming as a coping strategy and restricts the manifestations of depression (Table 5). The subscales characterizing maladaptive perfectionism are a predictor of the negative states as consequences of the pandemic COVID-19 - tension, anger, and Mental withdrawal as a coping strategy.

DISCUSSION

The majority of the publications in the field of sports psychology related to the pandemic COVID 19 are aimed at studying the psychological consequences (MacIntyre et al., 2020, Sokolowska et al., 2020, Jesus de la Fuente et al., 2020, Wang, Wang, Yang, 2020, Van Bavel et al., 2020, Schinke et al., 2020, Zhou et al., 2020, Leguizamo, et al., 2020, Iancheva et al., 2020). The psychological determinants of behavior in crises have been very poorly studied.

The obtained results from this research confirmed the hypothesis that the components of psychological capital of a person and perfectionism could be viewed as determinants of the domineering psychic states and preferred coping strategies in crisis (in this case, the pandemic COVID 19). The data showed that psychological capital stimulates Vigor, restricts the negative psychic states – Anger, Fatigue, and Depression, and determines the active coping strategies - Cognitive restructuring, Emotional calming, and Seeking social support.

Adaptive perfectionism stimulates emotional calming as a coping strategy and restricts the manifestations of depression. maladaptive perfectionism is a predictor of the negative states as consequences of the pandemic COVID 19 - tension, anger, and Mental withdrawal as a preferred coping strategy.
The researched athletes had the highest values on the scale of hope (Luthans, Youssef, Avolio, 2007, Luthans, Youssef-Morgan, Avolio, 2015). It is re-

lated to the development of independence, inner locus of control, high degree of autonomy and need for achievement and development, creativity, the tendency to make untraditional decisions, and risk-taking (Luthans, Youssef-Morgan, Avolio, 2015, Ilieva, 2019, Iancheva, 2020). Athletes with a higher level of hope prefer Cognitive restructuring as a coping strategy. They restructure their goals, try to block out negative thoughts, and concentrate on the essential things.

There were high values on the scale of Self-efficacy, which reflects the professional self-evaluation and supposes high motivation and goal orientation, and Optimism related to an optimistic way of thinking and flexibility of actions. Athletes with high levels of self-efficacy tend to choose Emotional calming as a preferred coping strategy and to mobilize their energy. The comparative analysis of the data revealed significant differences along the factors gender, and kind of sport.

We found higher levels of fatigue among the women in our research and significantly higher values of the active coping strategies - emotional calming, active planning, and cognitive restructuring. They tend to seek social support. The men reported higher values for parental expectations.

There were statistically significant differences along the factor sport in four of the researched indicators – Personal standards, Concern over Mistakes, Vigor, Fatigue, and Seeking social support. Perhaps the specific sports environment in the different spots affects the personal standards, the domineering psychic states, and seeking support for coping in crises.
The obtained results can serve as a good reference point in seeking the most efficient approaches not only to cope with crises in the case of athletes but also to implement preventive measures aimed at successful coping in various crises.

LIMITATIONS

This research has a few limitations - the number of the researched sample and the fact it was carried out online. A broader scope of research would allow for more in-depth analysis and interpretation.

REFERENCES

Andreato, L. V., Coimbra, D. R., and Andrade, A. (2020). Challenges to athletes during the home confinement caused by the COVID-19 pandemic. *Strength Cond. J.* 42, 1-5. Doi: 10.1519/SSC. 0000000000000563

Arden, M.A.& Chilcot, J. (2020). Health psychology and the coronavirus (COVID-19) global pandemic: A call for research. *British journal of health psychology*, *25 (2), 231-232* DOI: 10.1111/bjhp.12414

Avey, J.B., Reichard, R.J., Luthans, F. and Mhatre, K.H. (2011), "Meta-analysis of the impact of positive psychological capital on employee attitudes, behaviors, and performance", *Human Resource Development Quarterly*, Vol. 22 No. 2, pp.127–152.

Brooks, S. K. Webster, R.K., Smith, L.E. et al. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet*, *395, 10227*, 912-920. DOI: 10.1016/S0140-6736(20)30460-8

Burns, D. D. (1980, November). The perfectionist's script for self-defeat. Psychology Today, 34-52. Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., & Zheng, J. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Research*, 287, Article 112984. https://doi.org/10.1016/j.psychres.2020.112934

Curran, T., & Hill, A. P. (2019). Perfectionism is increasing over time: A meta-analysis of birth cohort differences from 1989 to 2016. *Psychological Bulletin*, 145, 410-429. https://doi.org/10.1037/bul0000138

De la Fuente, J., Kauffman, D., Dempsey, M., Kauffman, Y. (2020). Coronavirus Disease (COVID-19): Psychoeducational Variables Involved in the Health Emergency. (n.d.). Retrieved May 20, 2020, from https://www.frontiersin.org/research-topics/13709/coronavirus-disease-covid-19-psychoeducational-variables-involved-in-the-health-emergency

Egan, S. J., Wade, T. D., & Shafran, R. (2011). Perfectionism as a transdiagnostic process: A clinical review. *Clinical Psychology Review*, 31, 203-212. https://doi.org/10.1016/j.cpr.2010.04.009

Enns, M. W., & Cox, B. J. (2002). The nature and assessment of perfectionism: A critical analysis. In G. L. Flett & P. L. Hewitt (Eds.), *Perfectionism: Theory, research, and treatment* (pp. 33-62). Washington: American Psychological Association.

Frost, Heimberg, Holt, Mattai, Neubauer (1993). A comparison of two measures of perfectionism. *Personality and Individual differences*, 14, 119-126.

Frost, R., & Henderson, K.J. (1991). Perfectionism and reactions to athletic competition. *Journal of Sport and Exercise Psychology, 13, 323-335.*

Frost, R., Marten, P., Lahart, C., & Roseblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research, 14,* 449-468.

Hamachek, D. (1978). Psychodynamics of normal and neurotic perfectionism. *Psychology*, 15, 27-33.

Henriksen, K., Schinke, R., McCann, S., Durand-Bush, N., Moesch, K., Parham, W. D., et al. (2020). Athlete mental health in the Olympic/Paralympic quadrennium: a multi-societal consensus statement, *Int. J. Sport Exwrc. Psychol.,*18, 391-408. Doi: 10.1080/1612197X.2020.1746379

Iancheva, T. (2009). Adaptaciq na Multidimensional Perfectionism Scale (MPS) na Frost, Marten, Lahart, & Rosenblate (1990) za izsledwane na perfekcionizma v sporta, *Lichnost, motivaciq, sport,* T. 14, NSA PRES, 121-128 (In Bulgarian)// Янчева, Т. (2009). Адаптация на Multidimensional Perfectionism Scale (MPS) na Frost, Marten, Lahart, & Rosenblate (1990) за изследване на перфекционизма в спорта, Личност, мотивация, спорт, Т. 14, НСА ПРЕС, 121-128.

Iancheva, T. (2013). Perfectionism, Goal orientation, and Self-Efficacy with elite Rhythmic gymnasts, *The ISSP 13th World Congress of Sports Psychology*.

Iancheva, T., Rogaleva, L., García-Mas, A., Olmedilla, A. (2020). Perfectionism, Mood States, and Coping Strategies of Sports students from Bulgaria and Russia during the pandemic, *Journal of Applied Sports Sciences,* 1, 22-38.

Iancheva, T. (2020). Psychological problems in working and learning online, *Pedagogy, Vol. 92, 7s-Special Issue,* 152-162.

Leguizamo, F., Olmedilla, A., Núñez, A., Verdaguer, F. J. P., Gómez-Espejo, V., Ruiz-Barquín, R., & Garcia-Mas, A. (2021). Personality, coping strategies, and mental health in high-performance athletes during confinement derived from the COVID-19 pandemic. *Frontiers in public health*, *8*, 561198.

Luthans, F., Avolio, B., Walumbwa, F., & Li, W. (2005). The psychological capital of Chinese workers: Exploring the relationship with performance. *Management and Organization Review,* 1, 247–269. https://doi.org/10.1111/j.1740-8784.2005.00011.x

Luthans, F., Avolio, B. J., Avey, J. B., & Norman, S. M. (2006). Positive psychological capital: measurement and relationships with performance and satisfaction. *Personnel Psychology*, 60(3), 541-572. https://doi.org/10.1111/j.1744-6570.2007.00083.x

Luthans, F., Youssef, C. M., & Avolio, B. J. (2007). *Psychological Capital: Developing the Human Competitive Edge*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195187526.001.0001

Luthans, F., Norman, S. M., Avolio, B. J & Avey, J. B (2008). The Mediating Role Of Psychological Capital In The Supportive Organizational Climate – Employee Performance Relationship. *Journal Organizational Behavior*. I29: 219-238. https://doi.org/10.1002/job.507

Luthans, F., Youssef, C. M., & Avolio, B. J. (2015). *Psychological capital and beyond*. Oxford: Oxford University Press.

MacIntyre, T., Green, J., Beckmann, J., Lane, A., Vaughan, R., Morris, R., Murphy, E., Kenttä, G., Van Raalte, J., Calogiuri, G. (2020). The Effects of the Covid-19 Pandemic on Sport: Mental Health Implications on Athletes, Coaches and Support Staff. (n.d.). Retrieved May 20, 2020, from https://www.frontiersin.org/research-topics/14032/the-effects-of-the-covid-19-pandemic-on-sport-mental-health-implications-on-athletes-coaches-and-sup

Peterson, S., Luthans, F., Avolio, B., Walumbwa, F. and Zhang, Z. (2011), "Psychological capital and employee performance: A latent growth modeling approach", *Personnel Psychology,* Vol. 64, pp. 427–450.

Rea, S. (2020). Coronavirus: How Can Athletes get Through This Period of Isolation?. Available online at: https://www.open.edu/openlearn/health-sports-psychology/coronavirus-how-can-athletes-get-through-period-isolation (accessed September 20, 2020).

Schinke, R., Papaioannou, A., Henriksen, K., Si, GY., Zhang, LW. & Haberl, P. (2020). Sport psychology services to high-performance athletes during COVID-19. *International journal of sport and exercise psychology,* 17, 269-272. DOI: 10.1080/1612197X.2020.1754616

Sokolowska, J., Ayton, P., Brandstätter E. (2020). Coronavirus Disease (COVID-19): Psychological Reactions to the Pandemic. (n.d.). Retrieved June 04, 2020, https://www.frontiersin.org/research-topics/13744/coronavirus-disease-covid-19-psychological-reactions-to-the-pandemic.

Terry-Short, L. A., Owens, R. G., Slade, P. D., & Dewey, M. E. (1995). Positive and negative perfectionism. Personality & Individual Differences, 18(5), 663-668. 18(5), 663-668.

Van Bavel, JJ., Baicker, K., Boggio, PS., Capraro, V. et al. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature human behaviour*, *vol. 4,* 460-471. DOI: 10.1038/s41562-020-0884-z

Wang, J., Wang, JX. & Yang, G.S. (2020). The Psychological Impact of COVID-19 on Chinese Individuals. *Yonsei medical journal*, *61 (5),* 438-440. DOI: 10.3349/ymj.2020.61.5.438

Zhou, K, et al. (2020). Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 395, pp.1054-1062

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PHYSICAL AND SEXUAL VIOLENCE AGAINST ATHLETES

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ABSTRACT
The topic of sexual violence in sports, especially amongst children and young athletes, and after the huge scandal related to women's gymnastics in the US in 2016, is very relevant in today's society. This concept of sexual violence is not unknown to the Bulgarian sports society either. The topic is not alien to Bulgarian sports circles either. For this study, in April 2021, an anonymous survey was conducted with 187 students from NSA "Vassil Levski" to determine whether this type of violence was committed in Bulgarian sports clubs and teams. To ensure anonymity, no personal information was required in the questionnaire, except for the gender of the person filling in the questionnaire. It was found that 10.7% identified themselves as victims of violence, and 2.1% of respondents identified themselves as victims of sexual violence by their coach. After a discussion with students (n = 50), it was found that there are differences in the understanding of sexual violence. The study concludes that young people in Bulgaria need to undergo training about sexual violence to protect themselves and know how to react when encountering a sexual abuser.

Keywords*: sexual harassment, violence, coaches, teammates, victim*

INTRODUCTION

Every day, millions of children worldwide are victims of some form of violence at the hands of acquaintances and strangers (parents and relatives, teachers, peers, and strangers). Violence is committed in the home, at school, in the streets, and in the media, and seen as such, and it becomes part of everyday life (Pinhiero, 2006).

Violence is a phenomenon that affects everyone, especially those who are employed in the field of education, including sports and competition. It is a social phenomenon and an act that is often identified with aggression and bullying. In recent years, violence among children and young people has gained prominence in all its forms and dimensions. This also could be seen in research and studies by governmental and non-governmental organizations. In April 2021, the UNICEF-Bulgaria report on the survey on violence against children in Bulgaria (UNICEF-Bulgaria, 2021) came out, which is rather worrying.

Theoretical framework

In the scientific literature, violence is seen as physical, psychological, emotional, and sexual. Depending on the place where the different forms of violence occur, it is classified as domestic, workplace, or community violence.

The subject of this study is sexual violence in the sporting community, and more specifically among athletes when they, themselves, are victims. This issue is addressed in scientific and legal circles and is also of interest to the World Health Organization (WHO) and UNICEF.

According to the World Health Organization, sexual violence is any sexual act or attempted sexual act by coercion, including sexual acts or unwanted comments with sexual overtones by a person, no matter in what relationship with the victim (Fenerova, 2021).

UNICEF adds and specifies the definition that sexual abuse can also be referred to when a child (under 14) is involved in sexual acts that he/she does not understand and, due to his/her young age and immaturity, is not competent and able to refuse (UNICEF-Bulgaria, 2018). According to The Centers for Disease Control and Prevention (CDC): "*a sexual act that is committed or attempted by another person without freely given consent of the victim or against someone who is unable to consent or refuse*" (Basile et al., 2014).

This type of violence is viewed quite broadly. For example: when a person is forced to perform any kind of sexual act against his or her will; it is any sexual act between an adult and a minor (but also between minors) when one of them asserts his power over the other, i.e., forces them; it is a sexual act between an adult and a minor; coercing and/or persuading a child to engage in

a sexual act is itself also violence; verbal abuse on a sexual topic; the violation of a person's sexuality; non-contact acts such as exhibitionism, voyeurism, pornography, talking sexually in person, on the phone, through emails and/or on social networks with children and young people. Sexual violence is not always associated with an aggressive display of sexuality. This is because sexuality is characterized by the fact that it has no standards of what is normal or not. The mark that characterizes sexual violence is the presence of one party's physical and/or emotional suffering in these acts, including the manifestation of some feelings that one party does not want to feel (Fenerova, 2021). In these actions, there are two parties - the abuser/aggressor and the victim, who, through some form of coercion (threat, force, intimidation, manipulation), carry out the wishes of the abuser. In this case, the victim is forced to perform and/or endure some acts of a sexual nature, and when asked to stop, the abuser does not comply.

Globally, sexual violence is not studied in isolation. The reasons for studying sexual violence are mostly related to the fact that it leads to different types and severity of consequences. For this reason, taking measures for prevention, intervention, and therapy is appropriate when such is detected. Most often, victims of sexual violence experience feelings of embarrassment, and shame, withdraw into themselves, become disillusioned with people, and stop their usual activities and work. Physical, psycho-emotional, health, sexual and reproductive problems are observed in more severe cases. Victims may become depressed, self-blame, and experience increased anxiety and post-traumatic stress, including suicide attempts. It is also widespread to observe the phenomenon that in most cases, the victim of sexual violence knows the abuser, he/she is from her/his close environment.

Cases of sexual violence among athletes

According to Brackenridge (2001), sexual violence in sports is a sociological and cultural, but also interpersonal and psychological phenomenon (Brackenridge, 2001).

Several major scandals have erupted in sports recently, with violence against athletes, especially sexual violence, a taboo topic until recently.

In September 2016, however, the biggest sexual assault scandal in sports history broke out in the United States of America. Under the pretext of providing medical services, Larry Nassar, the longtime doctor of the U.S. national gymnastics team, inflicted this kind of violence on young gymnasts. More than 265 women, including former national athletes, have accused Nassar of sexual assault and child pornography. In the history of sports, Larry Nassar will be remembered as a serial sexual abuser, with his victims, at the time of the abuse, being underage girls, even 8-9-year-old children. John Geddert, the head coach of the 2012 U.S. Olympic team, has also been implicated in the scandal, physically, emotionally, and sexually abusing his female athletes. He used force, deception, and coercion on young girls, motivating them with fear and intimidation that often bordered on abuse (BBC News, 2018; Murphy, Barr, 2021). In addition to the Nassar-Gedert "tandem," other coaches have been accused of sexually abusing athletes, mostly underage girls. Sadly, in 2005, a Bulgarian gymnastics coach was convicted in the United States of sexually assaulting and abusing a 13-year-old girl competing in his club.

In the United States, more than 368 women claim to have been sexually assaulted by coaches and staff at sports clubs. The accused include 115 people with varying levels of professional development in sports, from novice coaches to those who prepare national athletes. The youngest disclosed victim of these abuses is 6 years old. Coaches exploit children's Olympic dreams, and victims are embarrassed, ashamed, and silent (Evans, Alesia, Kwiatkowski, 2016).

Cases of sexual abuse of children playing sports have also been reported across Europe. Brackenridge and colleagues (2005) analyzed 132 cases of child sexual abuse in the British Football Association. They found that 92% of abusers were male, with ages ranging from early adolescence to age 60. The majority were coaches/teachers of the victims (35%), 14% of the perpetrators were part of the administration, 21% were referees, and 7% were teammates of the reported sexually abused athletes (Brackenridge, Bringer, Bishopp, 2005). The Dutch National Olympic Committee and the Dutch Sports Confederation have a hotline where sexual abuse and harassment cases can be reported following a high-profile case among child athletes in 1996. Vertommen et al. (2015) examined 323 incidents reported and recorded on this helpline between 2001 and 2010 related to sexual harassment and violence and found that the majority of harassers were male coaches (77%) and 13% re-

ported harassment/violence perpetrated by another athlete or group of athletes (Vertommen et al., 2015). According to Vertommen et al. (2016), sexual abuse is less prevalent than psychological and physical abuse of children playing sports, which, however, receives less attention in some European countries (Vertommen et al., 2016), and according to Mountjoy et al. (2016), sexual abuse is highly prevalent in sport settings. However, they differentiate it into sexual harassment and sexual assault (Mountjoy et al., 2016). In our view, it is also important to make such a distinction. The need for this is supported by two international studies of female athletes conducted in Turkey (n=356) and Kenya (n=339) (Gündüz, Sunay & Koz, 2007); (Rintaugu et al., 2014). Gündüz et al. (2007) found that ¼ of the women studied self-identified as victims of sexual harassment by their coaches, 33% by teammates and others felt victimized by spectators in the stands (Gündüz, Sunay & Koz, 2007). Rintaugu et al. (2014) have reached similar results. According to them, most women are victims of sexual harassment by spectators (according to 32% of the women surveyed), followed by teammates (23%), and in 8% of the cases recorded, a coach or a person from the coaching staff was mentioned (Rintaugu et al., 2014).

A major scandal regarding violence in sports, including sexual violence, began in the summer of 2020 in British gymnastics when several victim gymnasts, both girls, and boys, made public statements about athlete abuse in gymnastics (Ingle, 2022; Whyte, 2022).

Prompted by the publicized cases of sexual violence among athletes in the world and by the presented results of UNICEF-Bulgaria on the prevalence of sexual violence among children in our country, conducted in the period 2019-2020, we set ourselves the goal of investigating the level of prevalence of this type of violence among athletes in our country, since they are not a target group in the UNICEF study. Another reason for the research interest is the specificities of sport-competitive activity and the hypothetically higher risk of this type of violence. Athletes and coaches often have to spend long periods of time together, sometimes away from home and parental supervision - during competitions and tournaments, at training and recovery camps. Physical contact between coach and athlete, especially in some sports, is unavoidable, especially in younger age groups.

METHODOLOGY

To ascertain the extent of types of violence among athletes, we conducted an anonymous empirical survey. For the study, we developed an anonymous Google Forms survey that was distributed for completion online and available for one week in May 2022. The dissemination is realized through the distance learning platform of the National Sports Academy „Vasil Levski“ (http://www.virtual.nsa.bg/), by e-mail to coaches with a request to provide it to their athletes, known athletes, and former athletes, including with a request to distribute it. Our preliminary plans and expectations were to include between 500 and 1000 current and former athletes in the study. The online survey was completed by 314 athletes (Table 1). We assume that the sensitivity of the issues proved to be decisive for the reluctance of athletes to participate in the survey.

Table 1. *Participants*

Variables	Groups	Valid Percent (%)	Frequency (n)
Gender	Female	54.1%	170
	Male	45.9%	144
	Total	100%	314
Age	18-20 years	37.6%	118
	21-39 years	51.3%	161
	40+ years	11.1%	35

Of the individuals surveyed, the highest proportion was of club athletes - 36.3% (n=114) and former athletes with club affiliation only - 34.1% (n=107). Representatives of national teams by sport type totaled 72, of which former athletes accounted for 15% of the persons surveyed (n=47). A small proportion of the participants in the study - students at the NSA "Vasil Levski" (n=21) stated that they were not ath-

letes but were involved in sports. Only 20.4% (n=64) of the study participants were female coaches. 63.4% (n=199) of the athletes worked with male coaches and the remaining 16.2% (n=51) conducted sport-competitive activities with both female and male coaches.

In order to guarantee the anonymity of the subjects, due to the sensitivity of the issues, only the gender of the studied athletes and their coaches was indicated in the questionnaire as personal information. In order to minimize concerns, the type of sport, the club, and the location were not mentioned in the questionnaire, as the idea was to use this study to outline the framework and scale of sexual violence among Bulgarian athletes. The questions asked were not specific and clarifying, such as what type of sexual violence and whether it could be treated as sexual harassment, what was the severity, what were the consequences, etc., but were more generally formulated: 'Have you been sexually abused by a coach' and 'Have you been sexually abused by a teammate'. Since, according to the definitions of sexual abuse, it is sometimes accompanied by physical abuse, we included the following questions in the questionnaire: 'Have you ever been a victim of physical abuse by a coach'; 'Have you ever been a victim of physical abuse by your parents'; and 'Have you ever been a victim of physical abuse by a teammate'. The questions were answered on a four-point Likert-type scale, with 1 indicating "no, it has never happened", 2 indicating "yes, it has happened once, twice at most", 3 indicating "it has happened sometimes" and 4 indicating "yes, it has happened quite often". The study also began with a general question - we were interested in whether athletes self-identified as victims of violence.

RESULTS AND DISCUSSION

As a result of the empirical study, it was found that 11.1% of the studied athletes (n=35) - 19 females and 16 males - self-identified as "victims" of violence (all forms of violence - generalized). Interesting data are observed in the age distribution of responses. Our prediction was that former athletes over the age of 40 would be most likely to self-identify as a victim of abuse. These are the people who, when they were of active competitive age, lived under socialism and post-socialism. At that time in our country, there was still no Child Protection Act adopted, the Convention on the Rights of the Child had not been ratified, and there were no texts included in other legal documents that prohibited physical and mental abuse of children (Vladova, Martinova, 2021), the use of corporal punishment was not prohibited in sports practice, and it was present in educational practice in families, in school and during training. Despite all this, only two former athletes in this age group reported being victims of violence. The most significant number (n=21) who self-identified as a victim of violence were in the 21-39 age group, and in the youngest group of athletes, 12 felt they had been a victim of violence. We attribute this data to the fact that young people today are more informed, they know their rights, and they can define what violence is, so they have given these answers.

The data in terms of physical violence is not concerning and is presented in Table 2. Notably, the highest values were reported physical abuse by parents (M=1.49; SD=0.812), which in turn did not have high values. Teammates were least likely to report physical violence towards each other (M=1.27; SD=0.629).

Table 2. *Results of the analysis of variance in physical violence*

	N	Min	Max	M	SD
Have you been a victim of physical abuse by a coach?	314	1	4	1.38	0.775
Have you been physically abused by your parents?	314	1	4	1.49	0.812
Have you been a victim of physical abuse by a teammate?	314	1	4	1.27	0.629

Regarding the occurrence of physical violence, a comparative analysis was implemented using the Mann-Whitney and Kruskal-Wallis hypothesis testing methods. Statistically significant differences were found for the coach's reporting of physical violence on the factor "coach's gender" (Kruskal-Wallis H) (Table 3).

Table 3. *Results of the comparative analysis on the factor "gender of the coach"*

	Have you been a victim of physical abuse by a coach?
Kruskal-Wallis H	4.876
df	1
Asymp. Sig.	.027

Pairwise comparative analysis (Mann-Whitney) showed that significant differences were between female coaches and male coaches (U=5495.000, p=.027) and between female coaches and mixed coaching groups (U=1332.000, p=.028). From the analysis of variance, we found that female coaches were more likely to engage in physical violence (M=1.66; SD=1.04) than male coaches (M=1.34; SD=.705) and mixed coaching staff (M=1.22; SD=.541). No statistically significant differences were observed on the factor of the gender of the subjects, but it was observed on the factor of age and sport affiliation (Table 4).

Table 4. *Results of the comparative analysis by the age and sports affiliation factor*

Have you been a victim of physical abuse by a coach	**Age group**	**Club affiliation**
Kruskal-Wallis H	6.590	20.817
df	2	4
Asymp. Sig.	.037	.000

Pairwise comparative analysis (Mann-Whitney) showed statistically significant differences for coach-reported physical abuse between club athletes and student-athletes who do not have a club affiliation (non-athletes) and former club-level athletes (U=5145. 000, p=.004), between club athletes and national team athletes (U=1201.500, p=.053), and between club athletes and former national team athletes (U=1911.000, p=.000). Data from the analysis of variance showed that students who were not actively involved in competitive sport were the least likely to be victims of physical abuse by a coach (M=1.14; SD=.655), which is also logical for athletes who had a club affiliation (M=1.18; SD=0.508). Former national team athletes were most likely to indicate that they experienced physical abuse from their coaches (M=1.72; SD=1.015), whereas former club athletes (M=1.47; SD=.828) and current national team members (M=1.48; SD=.872) had similar perceptions of physical abuse.

The data presented is not disturbing, nor are the results regarding sexual violence. The data from our study do not confirm the data presented by UNICEF-Bulgaria that one in five girls and one in ten boys in Bulgaria is a victim of sexual violence (UNICEF-Bulgaria, 2018). Also, this study's results confirm our previous study of student-athletes only, in which 97.9% of the subjects did not self-identify as a "victim" of sexual abuse by their coach, with only two girls and two boys stating that it happened to them frequently. Regarding the gender of the coach - in one case, the abuser was a woman who often resorted to this vicious practice. No cases of sexual violence have been reported with mixed coaching staff (Vladova, Kuleva, 2022).

The results of this study indicate that athletes generally do not self-identify as victims of sexual abuse by coaches (M=1.04; SD=0.292) and teammates (M=1.04; SD=0.307). In this study, the majority of athletes surveyed stated that they had never been sexually harassed by their coaches - 98.4% of them stated this, and 98.1% had never been sexually harassed by their teammates. A total of three women and two men were victims of sexual abuse by their coaches, with only one woman and one man stating that it happened quite frequently. Three women were victims of sexual harassment by their teammates, with one of them stating that it happened quite often, and three men, two of whom suffered from this behavior quite often. The results of the previous study were similar - then 3 victims (two men and one woman) of sexual assault by a teammate were recorded, and two of them reported that these incidents occurred frequently.

The Kruskal-Wallis test indicated the presence of a statistically significant difference in the factor "sports affiliation" when reporting the presence of sexual violence by a teammate (p=.002). Pairwise

comparative analysis (Mann-Whitney) showed that there were differences between the groups of club athletes and those of the national teams (U=1254.000, p=.000), which was also true for sexual abuse by coaches (U=1368. 000, p=.033) as well as between the groups of club athletes and former club athletes, where there were differences on both questions: victim of coach (U=1140.000, p=.020) and victim of teammate (U=1140.000, p=.020). Statistically significant differences by gender of athletes and gender of the coach were not recorded.

- As we found in our previous research, very often, sexual violence takes place among acquaintances in the community. Also, the empirical data from the previous study was supported by the results of an online talk and discussion with second-year students on "Sexual violence - what is it?" discussing the following questions:
- Is it sexual violence to make sexist jokes; the hissing and whistling with a sexist flavor; to make a comment with a sexual connotation (incl. a comment about clothing, body, or appearance); to look intrusively; to violate personal space - to get too close to someone; to be physically contacted and touched, incl. during practice by a coach or teammate; to have a massage initiated by a coach or teammate; to insist on being left alone, e.g., In the locker room; receiving calls, emails, messages, photos, videos with sexual context; receiving calls, emails, messages, photos, videos of you in a compromising or sexual position; forced kissing; forced undressing and/or taking a sexual position; performing sexual acts with or without a camera; sexual touching without your consent; attempted sexual contact without your consent.

All these allegations/questions can be defined as different types of sexual violence. According to the students involved in the discussion, most of the students' responses and comments regarding sexist jokes, comments, and hissing could not be defined as sexual violence and very often could not even be categorized as sexual harassment. Moreover, here is the place to address the cultural context and interpretation. According to some young women, it is a matter of honor and even a compliment if a man uses sexist jokes in communication with them. Out of all the learners who participated in the discussion (n=50), only two students, one male, and one female, expressed the opinion that this kind of jokes are definitely sexual violence. What impressed them was their knowledge of the subject, and when asked by the presenter what had provoked them to be interested in this topic, they mentioned that they had participated in projects that dealt with this issue (independently of each other).

In conclusion, it is important to clarify that yes - the Bulgarian mentality, and understanding in general, does not treat these actions as sexual violence. However, when it causes embarrassment, discomfort and shame, we should already think about whether this is sexual violence or sexual harassment, whether unwanted sexual attention should not be categorized as violence.

According to the majority of student-athletes, sexual violence is primarily associated with unwanted sexual contact or performing sexual acts against one's wishes. For this reason, they believed that the measures to be taken when such type of violence is found should be mainly legal and medical. Again, the students involved in the projects added that the measures should also be psychological because often, many victims of sexual violence experience overwhelming shame, guilt, post-traumatic stress, and depression, including isolation, alcohol and drug abuse, self-harm, and suicide attempts.

The British Gymnastics scandal found 67% of emotional abuse of gymnasts, 49% of physical abuse, and 9% of sexual abuse. Some athletes have said that more than one type of violence was carried out on them (Whyte, 2022).

It is important that sports and sporting activities are safe and bring only positive experiences, regardless of the age and skill of the athletes. Practices that cause physical, emotional and sexual harm should not be implemented (Whyte, 2022).

CONCLUSIONS

As a result of the survey, we can conclude that young people in Bulgaria need training on sexual violence. This is necessary to protect themselves from such violence and know how to react when they meet a sexual abuser. It is also important that they themselves are able to recognize 'victims' of sexual violence and are competent in providing assistance, being able to assist. It is important to provide good protection for young people, and better protection for athletes.

REFERENCES

Basile, K., Smith, S., Breiding, M., Black, M., & Mahendra, R. (2014). *Sexual violence surveillance: uniform definitions and recommended data element*s (2.0). Atlanta: National Center for Injury Prevention and Control of the Centers for Disease Control and Prevention.

BBC News (2018). Larry Nassar case: USA Gymnastics doctor 'abused 265 girls' Published 31 January 2018. URL: https://www.bbc.com/news/world-us-canada-42894833 (Accessed on 12.04.2021)

Brackenridge, C. (2001). *Spoilsports: Understanding and preventing sexual exploitation in sport*. Book, London: Routledge.

Brackenridge, C., Bringer, J. D., & Bishopp, D. (2005). Managing cases of abuse in sport. Child Abuse Review, 14(4), 259–274. http://dx.doi.org/10.1002/car.900

Evans, T., Alesia, M., Kwiatkowski, M. (2016). *A 20-year toll: 368 gymnasts allege sexual exploitation*. The Indianapolis Star. URL: https://eu.indystar.com/story/news/2016/12/15/20-year-toll-368-gymnasts-allege-sexual-exploitation/95198724/ (Accessed on 17.04.2021)

Fenerova, I. (2021). Kakvo e seksualno nasilie i kakvi sa posledstviyata ot nego. Retrieved on July 4, 2022 from https://psychology.framar.bg/какво-е-сексуално-насилие-и-какви-са-последствията-от-него

Gündüz, N., Sunay, H., & Koz, M. (2007). Incidents of sexual harassment in Turkey on elite sportswomen. *The Sport Journal*, 10, 1–10. Retrieved from. http://thesportjournal.org/article/incidents-of-sexual-harassment-in-turkey-on-elite-sportswomen/

Ingle, S. (2022). British Gymnastics braces for publication of damning report on abuse. Retrieved on Wed 15 Jun 2022 https://www.theguardian.com/sport/2022/jun/15/british-gymnastics-braces-for-publication-of-damning-anne-whyte-report-on-abuse

Mountjoy, M., Brackenridge, C., Arrington, M., Blauwet, C., Carska-Sheppard, A., Fasting, K. & Budgett, R. (2016). The IOC consensus statement: Harassment and abuse (non-accidental violence) in sport. British *Journal of Sports Medicine*, http://dx.doi.org/10.1136/bjsports-2016-096121

Murphy, D., Barr, J. (2021). Ex-USA Olympic gymnastics coach John Geddert faces 24 felony charges, including human trafficking, sexual assault. URL: https://www.espn.com/olympics/gymnastics/story/_/id/30962773/former-usa-olympics-gymnastics-coach-john-geddert-charged (Accessed on 17.04.2021)

Pinhiero, P. S. (2006). World Report on Violence against Children. Geneva: United Nations. Retrieved on July 4, 2022 from http://www.unviolencestudy.org/

Rintaugu, E. G., Kamau, J., Amusa, L. O., & Toriola, A. (2014). The forbidden acts: Prevalence of sexual harassment among university female athletes. *African Journal for Physical, Health Education, Recreation and Dance,* 20(3), 974–990.

UNICEF-Bulgaria (2018). Nasilie nad detsa. Retrieved on July 4, 2022 https://www.unicef.org/bulgaria/sites/unicef.org.bulgaria/files/2018-11/Violence%20against%20children-bg.pdf

UNICEF-Bulgaria (2021). Izsledvane na nasilieto nad detsa v Bulgaria. Rezyume. Retrieved on July 4, 2022 from https://www.unicef.org/bulgaria/media/10246/file

Vertommen, T., Schipper-van Veldhoven, N., Hartill, M. J., & Van Den Eede, F. (2015). Sexual harassment and abuse in sport: The NOC*NSF helpline. *International Review for the Sociology of Sport*, 50(7), 822–839. http://dx.doi.org/10.1177/1012690213498079

Vertommen, T., Schipper-van Veldhoven, N., Wouters, K., Kampen, J. K., Brackenridge, C. H., Rhind, D. J. A. & Van Den Eede, F. (2016). Interpersonal violence against children in sport in the Netherlands and Belgium. *Child Abuse & Neglect: The International Journal*, 51, 223–236. http://dx.doi.org/10.1016/j.chiabu.2015.10.006

Vladova, I., Martinova, I. (2021). Aggression Among Pupils In Bulgaria In The Period 2015-2018 V: *Godishnik na Natsionalna sportna akademia „Vasil Levski"*, tom 1, pp. 222-229

Whyte, A. (2022). The Whyte Review. Retrieved on 04 July, 2022 from https://www.whytereview.org/assets/downloads/The-Whyte-Review-Final-Report-of-Anne-Whyte-QC.pdf

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PHILOSOPHY

DYNAMICS IN THE DIFFICULTY IN RHYTHMIC GYMNASTICS COMPETITIVE ROUTINES

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ABSTRACT
Rhythmic gymnastics, like other sports disciplines called "artistic", is continuously developing in a sports-technical sense. Gymnastics varieties, such as "dance gymnastics", "rhythmical gymnastics", "expressive gymnastics", and "plastic and stage expression gymnastics" have lost their individuality but different elements of their means of expression find their place in the requirements for composition. The efforts of the specialists in this sport are aimed at preserving the identity of this sports discipline, namely, using various musical accompaniments and a wide range of dance movements combined with complex exercises.
The aim of the research was to trace the development of the difficulty in routines and a retrospect of the main indicators for making competitive routines for the period 1963-2021 was made with the use of a theoretical and synthesis method. The evaluation of dance elements and complex exercises in competitive programs of gymnasts was in the very first Code of Rules known. There are three different components – difficulty of the exercises, general impression, and accuracy of execution.
The general changes in the difficulty of the exercises can be clearly seen if we divide the Codes of Rules into the following periods: 1) 1963-1971, 2) 1976-1984, 3) 1997-2005, and 4) 2009-2021.
The changes are due to two major factors: - objective – perfection of the training process, emergence of new exercises, gymnasts' exclusive motor abilities; choreographs, musicians, dancer' participation in gymnasts' preparation; - subjective – creation and modification of the rules by members of rhythmic gymnastics technical committee who are representatives of different schools and cultures, with different concepts about the development of the future image of this sport. The retrospect of the requirements in the competitive rules shows that the greatest transformation of rhythmic gymnastics is in its turning into a complex sport.

Keywords: *Rhythmic gymnastics, difficulty, evaluation*

INTRODUCTION

Dance was born out of religious gestures as a spontaneous expression of celebration, an act of the unit of spirit and body. According to people's understanding, dance was a form of art which took one away from one's enemies, drove away diseases, gave one the powers of Gods. Dance as a means of expression of feelings and emotions has persisted throughout human history (Diem, 1966). People sometimes danced in a group by taking different body postures, followed by returning to initial position in strict obedience to a certain rhythm. The use of different objects was found in a number of historical records. They were given mysterious and divine meaning or were just objects bringing variety into a game.

In their dances, the Aztecs used a ball as a symbol of the sky. It was made from the juice of a rubber tree which is interpreted as a symbol of the sacred, of God's soul (Diem, 1966).

In ancient China, during the rule of emperor Yan-Kang-Shi, gymnastics exercises in a group were practiced with or without an apparatus or with small apparatuses. The exercises included bends backwards, bridges, and exercises for overall development (Petrova, 1982; Liang, 2012). *The play with a ball involved balance exercises, tossing the ball in the air while leaping or other exercises, and subsequent catching the ball in a sitting position* (Bobo, 1998).

In ancient Greece, people practiced strength and *dance gymnastics*, including various *preparatory and imitation dances, different postures* and exercises with *balls, hoops and veils, performed with musical flute accompaniment (*Lisitzkaia, 1987).

Later on, dance played a central role in *dance gymnastics*, whose principles as defined by George Demeny (1850–1917) were also applied to rhythmic gymnastics (Biriuk, Ovchinnikova, 1990): each movement should follow in sequence; harmonious participation of all body parts in the executed movement; limbs should move in all planes and directions; need of high level of development of balance and spatial orientation; obedience to the principle of gradual complexity, etc. Demeny further developed common principles taken from the

traditional activities, smooth and oval motions, rhythmic movements for flexibility, and at a later stage, he included skipping, play with clubs, play with a hoop and with two apparatuses (Vigarello, 1993, Zoro, 2002). Isadora Duncan (1878-1927) rejected the constrained and conventional methods of classical dance (Atanassova, 1977) because she found them rigid and formal (Dunkan, 1972) and created a new style of natural movements as well as developing a system consisting of basic dance movements which called "notes from the scale of movements" (Naipak, 1985).

Aim of the study

In the process of reviewing codes of points in rhythmic gymnastics, starting with the first Code published in Russia, as well as FIG's 1963-2021 rules, the idea was formed to learn more about the structure and distribution of evaluation criteria.

To this end, the **aim** going forward was defined as tracing the evolution of competition rules, specifically where the evaluation of competition routines' artistic aspect was concerned.

METHODOLOGY

A method based on theory and synthesis was used to analyze the following: codes of points; technical requirements for composing competition routines; historical texts concerning the sport; photographs and videos; relevant publications; interviews; and websites.

RESULTS AND ANALYSIS

Women's desire to dance to musical accompaniment, the use of small portable apparatuses of varying nature and shape, and the influence of different gymnastics schools and systems laid the foundation of the emerging physical discipline practiced in Russia (Petrova, 1982, Geshev, Petrova, 1970).

Studios, schools, and extracurricular activities with different kinds of artistic and graceful movements were created, known under various names, such as "expressive gymnastics", "rhythmical gymnastics", "gymnastics for graceful and stage expression" (Karpenko, 2003, Tzvetkova, 2002).

The Supreme School for artistic movements initiated the in-depth work in the field of artistic movements and in 1934 the school was transformed into a department at the sports-pedagogical faculty of the institute "P. F. Lesgaft", Sankt Peterburg. 30 people enrolled in the first year, divided into 3 groups (one of them consisted of men), (Brikina, Smolevskii, 1985).

The curriculum included (Shishkarevoi, Orlov, 1954, Naipak, 1985):

Rhythmic gymnastics; Musical and stage etudes; Music literacy and solfeggio; Typical dances; Staging; Basic gymnastics; Athletics and fencing

It was named *art gymnastics* because it was believed that this type of sport had a close affinity to art (Karpenko, 2003).

The first competitions were held in the form of contests, with the winners receiving awards such as paintings, small statues, and other works of art made by young talented artists instead of medals (Petrova, 1984, Tzvetkova, 2002).

The program for participants in contest competitions consisted of two parts:

First part – a compulsory program and *Second part* – finals, the top ten gymnasts compete

The compulsory program, which was the qualification for the finals, included four exercises (Biriuk, 1990):

1. Compulsory routine without an apparatus;
2. A routine with acrobatic exercises;
3. One of the six compulsory routines with an apparatus (the apparatus was determined by a draw, but competitors prepared routines with all apparatuses);
4. One of the three compulsory jumps off a springboard. During the compulsory exercises, following a decision made together with her coach, the gymnast could raise her hand to waive her score and was then allowed to repeat her routine. The competition finals were held on a theatrical stage, comprising two free routines – one with and one without an apparatus. For the apparatus-free routine, elements of dance, pantomime, acrobatics, and somersaults were permissible.

The traditional apparatuses used at the time were: hoop, ball, ribbon, steamer, clubs, veil, and rope. Gymnasts were allowed to perform their routines with two apparatuses simultaneously: two ribbons, two hoops, a ball, and a hoop, a ball, and a steamer.

The choice of apparatus was often dictated by competitors and coaches' fantasy and that's why there were often strange decisions (Biriuk, 1990): A veil on a stick; A ball, threaded on a rope; huge balls colored in golden; balls covered with glowing sequins; clubs in the shape of snowflakes; a ribbon with the width of a veil.

The competitive routines were judged in three aspects Figure 1 (Biriuk, 1990):

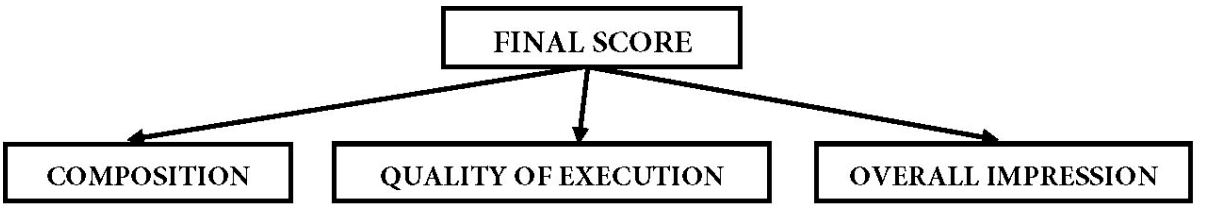

Figure 1. *Score components*

No data about the values of the different components or the final score have reached us, nor about the specific requirements for the contents of the competition routines, but these components of the final score have undoubtedly been an immutable basis for the evaluation of rhythmic gymnastics competition routines ever since it was recognized as an official discipline.

Table 1. *Routine contents and evaluation method: Codes of Points 1963–2021 (Rodenas, 1996, Gantcheva, 2008, 2021).*

YEAR	SCORE DIVISION
1963 **1965**	**Range form 0 to 10 points** **5 p. – composition** 3 p. – value of the elements of the difficulty 2 p. – originality of connections and technical value of composition **5 p. – execution** execution of elements ***Harmony and overall impression*** **Final score – 10 p.**
1968 **1971**	**Range form 0 to 10 points** **7 p. – composition** 5 p. – value of the elements of the difficulty 1 p. – originality of connections and technical value of composition 1 p. – connection music and movements **3 p. – execution** 1.5 p. – execution of the elements 1.5 p. – ***Harmony and overall impression*** **Final score – 10 p.**
1976 **1978** **1982** **1984**	**Range form 0 to 10 points** **7 p. – number and value of difficulty** 1 т. – connection music and movements 0.5 p. – technical value of composition Division of the difficulty of the routine Connections between difficulties and the elements Variety of the groups, rhythm, planes, and directions 0.5 p. – originality, new elements, new connections **3 p. – Execution** 1.5 p. – execution of the elements 1.5 p. – ***overall impression*** Certainty, Elegance, Coordination, Dynamics, Easiness, Amplitude of the movements ***Expression, presence*** **Final score – 10 p.**

1989	**Composition – 10.0 p.** 9.5 p. – technical value 0.3 p. – ***bonus originality*** 0.2 p. – bonus risk **Execution – 10.0 p.** 9.7 p. – execution 0.3 p. – ***bonus virtuosity*** **Final score** – 10 p.
1993	**Composition** – 0-5 p. **Execution** – 0-5 p. **Final score – 10 p.**
1997	**Score A1: - 0-5 p.** 4 separate elements with apparatus difficulty for 2 p. 8 difficulty elements B, C, D – 3 p. **Score A2: – *artistic value* – 0-5 p.** **Score B: - execution - 10 p.** **Final score – 10 p.**
2001 **2003**	**Score A1: – technical value – 10 p.** 10 difficulty – combinations or isolated elements **Score A2: – *artistic value* – 10 p.** Music ***Choreography*** Specific artistic characteristic - Body - movements - Step – without step - Mastery - Originality **Score B: – execution – 10 p.** **Final score – 30 p.**
2005	**Score A1: – technical value – 10 p.** Min 6 difficulties from the required body group 6 difficulties (max 2 of non-required group difficulties) Max 18 difficulties **Score A2: – *artistic value* – 10p.** 1.0 p. – Music 2.0 p. – ***Choreography*** 7.0 p. – Specific artistic characteristic - Body – apparatus - Mastery - Originality **Score B: – execution – 10 p.** **Final score – 20 p.**
2009	**Score D: – difficulty – 10p.** D1 – body difficulty (10-12 elements) D2 – apparatus difficulty **Score A: – *Artistry* – 10p.** - Music - Choreography **Score E: – execution – 10 p.** **Final score – 30 p.**

2013	**Composition: 10 p.** - body difficulty, - combination dance steps, - dynamic elements with rotations, - Mastery with apparatus. **Execution: 10 p.** - technical mistakes, - artistry mistakes. **Final score – 20 т.**
2017	**Score D: - difficulty:** D1 – body difficulty (D1+D2): – number and value of body difficulty (**BD**), number and value of combination dance steps (**S**), number of Specific technical group with apparatus. D2 – body difficulty (D3+D4): number and value of dynamic elements with rotations (**R**) difficulty with apparatuses (**AD**). **Execution**: E1 – execution (E1+E2): - artistry E2 – execution (E1, E2, E3, E4): - evaluate technical errors **Score D = D1+D2 – 10 p.** **Score E – 10 p.** **Final score – 20 p.**
2021	**Difficulty:** The first (**D**) subgroup - 2 judges (**DB1 and DB2**) – evaluates the number and technical value of Difficulties Body (**DB**), – number and value of Dance Steps Combinations (**S**), – recognition of Full Body Wave (**W**). The second (**D**) subgroup - 2 judges (**DA3 and DA4**) – evaluates the number and technical value of Dynamic elements with Rotation (**R**) – and the number and technical value of the Difficulty of Apparatus (**DA**) **Artistry:** 4 judges (**A1, A2, A3, A4**); evaluate artistic faults **Execution:** 4 judges (**E1, E2, E3, E4;** evaluate technical faults **Final score (open) – D+A+E**

DISCUSSION

The literature review showed that when it first started evolving into a sport discipline, rhythmic gymnastics had an entertainment core and was a field of innovation and creativity. At the same time, it was aimed at developing a physical activity suited to the female body, and simultaneously presented a way of expressing various artistic capabilities due to its affinity to dance and music (Table 1). The *overall impression* score, separate from the technical execution score, evaluated the gymnast's charm, grace, the expressiveness of her movements and face, the communication of images, emotions, feelings, and suggestions to the audience, achieved through the connection between music and movements. Their sum total comprises that part of *art* gymnastics which, in addition to giving the sport its name, is the artistic quality pursued by both coaches and athletes. The components listed above are a relative category and defy precise definitions and as such, precise evaluation. Creating scoring systems for the expressiveness of the execution, for the ability to express through movements the emotional nuances of the musical accompaniment, is impeded by the awareness that they are largely dependent on the gymnasts' individual characteristics (Smirnov, Ivanova, 1981). This is why judging this part of the routines is always hard, as it stands closer to the spectators (audience), who for their part evaluate it by their own criteria which vary from person to person. There is no real possibility for these criteria to be defined, systematized, and awarded the

same value for everyone in the audience, which also plays the role of a judge in a sense. As a result of the coaches' artistic pursuits, the discipline's content is continually enriched with new exercises, connecting elements, and combinations.

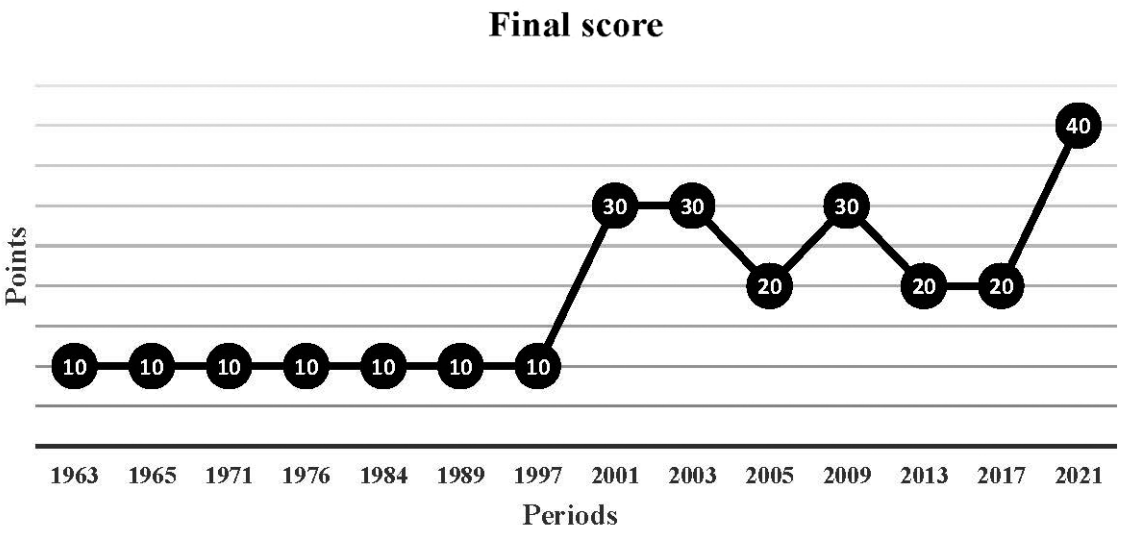

Figure 2. *Value of the final assessment of routines in rhythmic gymnastics (1963-2021)*

The Judges' Rules should guide the use of these exercises while evaluating the artistic aspect of the routines. The creators of the Code of Points have made attempts over the years to define a precise score structure and have proposed the development of a quantitative scoring system for qualitative expressions of various emotions in rhythmic gymnastics (Averkovich, 1979). At times it has seemed like the contents of the routines and the method for their evaluation are aligned. But it never lasts long, as in the meantime coaches have usually discovered new difficult, and original exercises and connecting elements. Thus, the rules must be adapted to the novelties, and in this sense, they are in a catching-up position.

Table 1 shows the increase in the number of exercises over the years, and with the duration of routines unchanged, the total difficulty has been increased again and again, with no Code of Points daring to overlook the evaluation of the artistic part of the routines, even if it adds a decidedly subjective element to the overall evaluation. The *overall impression* score in the first Code has consistently been kept in later editions, though under different names (*harmony and overall impression* in 1963, 1965, 1968, and 1971; *overall impression* between 1976 and 1984; *artistic value* between 1997 and 2005; *artistry* in 2009, 2013, 2016, 2021), as part of the composition score, with varying values, with changing criteria, but rhythmic gymnastics has been keen on preserving its main element, the foundation of its emergence as physical activity (Figure 1).

The difficulty of exercises and combinations is somewhat difficult to compare because different periods prioritize certain components. In 1963, and 1965, a limited number of exercises were planned, which became mandatory due to the lack of other opportunities. In the period 2001-2008, the focus is on body exercises. Gymnasts perform 28-30 exercises, and the device has a supporting function for evaluating body exercises and more precisely for awarding their value. The apparatus must be in motion, at the gymnast's choice, but this motion determines the duration of certain exercises, such as spins and balances. With the decision of the technical committee to pay more attention to the most specific component of rhythmic gymnastics, namely the apparatus game, led to the severe limitation of the number of body exercises. Repeating the number of rotations brings a higher number of points, and using these exercises leads to uniformity in the routines. The priority is playing with the apparatus, which fully covers the line of development of rhythmic gymnastics, determined by the technical committee.

CONCLUSION

Rhythmic gymnastics as a sport discipline has been developing towards a constant increase in the difficulty of exercises, but it has invariably maintained

the artistic aspect of the routines. Competition rules put serious emphasis on this component of the competitive sport. Even though evaluation of the artistic aspect has been based on criteria of varying structure, distribution, and values over the years, the core philosophy of the discipline has remained the same. The *overall impression* score continues to play its part in the final score calculation and helps preserve the specific characteristics of this gymnastics discipline. The new interpretation of the term artistry, namely that artistry is contained in the correct technical execution of the exercises, is a new point, but it needs to be filled with content.

REFERENCES

Atanassova, Tz. (1977). Izsledvane varhu sredstvata I metodite za nachalna sportna podgotovka po hudojestvena gimnstika (8-9- godishna vasrast), Disertatzia, VIF. Sofia.

Averkovich, E.P. (1979). Analiz proizvolnih uprajnenii v hudojestvennoi gimnastike I puti sovershenstvovania ispolnitelskogo masterstva silneishih gimnastok: avtoreferat disertatzii. GTZOLIFK. Moskva.

Biriuk, E.V. (1990). *Razvitie hudojestvennoi gimnastiki kak vida sporta. Metodicheskie rekomendatzii.* KGIFK. Kiev.

Biruk, E.V., Ovchinnikova, N.A. (1990). *Pedagogicheskie aspekti vozniknovenia hudojestvennoi gimnastiki kak spetzificheskoi sistemi fizicheskogo vospitania.* Методические рекомендации. КГИФК. Киев.

Bobo M. (1998). *Gimnasia ritmica deportiva*. Lea. La Coruña.

Brikina, A.T., Smolevskii, V.M. (1985). *Gimnastika – uchebnik dlia tehnikumov fizicheskoi kulturi.* F I S, Moskva.

Diem, C. (1966). *Historia de los deportes*. Luis de Carlat editor. Barcelona.

Dunkan, A. (1972). *Moiat tanz. Avtobiografia.* MiF.Sofia.

Gantcheva, G. (2008). Izsledvane i optimizirane metodikata na obuchenie na skokovete v hudojestvenata gimnastika. Disertatzia. NSA. Sofia.

Gantcheva, G. (2018, 2021). *Hudojestvena gimnastika – istoricheski aspekti*. BOLID INS. Sofia.

Geshev, A.T., Petrova, N. (1970). *Sistemi za fizichesko vazpitanie*. MiF. Sofia.

Karpenko, L.A. (2003). *Hudojestvennaia gimnastika. Ychebnik*. VFHG, SPGAFK "P. F. Pesgaft" M.

Lian, Z. (2012). An investigation the preparation system in physical fitness of rhythmic gymnasts aged 8 to 12 in Bulgaria and China. Doctorat. NSA, Sofia.

Lisitzkaia, T.S. (1987). *Plastika. Ritm.* FiS.Moskva.

Naipak, V.D. (1985). Stranitzii istorii – nachalo puti. *Sp. "Gimnastika", pervii vipusk*. FiS. Moskva.

Petrova, N. (1984). Po niakoi vaprosi ot predistoriata na hudojestvenata gimnastika v Balgaria. Iubileina nauchna konferentzia *"30 godini balgarska hudojestvena gimnastika" – dokladi,* Sofia.

Petrova, N. (1982). *Sistemi za fizichesko vazpitanie*. MiF. Sofia.

Rodenas, M.L. (1996). Hacia una objetivacion del codigo internacional de gymnasia ritmica deportiva.Tesis doctoral. Universitat de Barcelona. Barcelona.

Shishkariova, U.N., Orlov, L.P. (1954). *Hudojestvennaia gimnastika. Uchebnik.* FiS. Moskva.

Smirnov, U.I., Ivanova, O.A. (1981). Primenenie metoda semanticheskogo differentziala dlia otzenki ekspresii v gimnastike. *Sb. "Gimnastika"*. FiS, Vipusk pervii. Moskva.

Tzvetkova, L. (2002). *50 godini balgarska hudojestvena gimnastika*. "Balkan pres". Sofia.

Vigarello, G. (1993). *Mécanisme et* éducation *de mouvements par George Demenÿ*. Editions *Revu «EPS »*. Paris.

Zoro, J. (2002). *Images de 150 ans d'E.P.S.* Profil intermédia. France.

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SOME GENDER ISSUES AROUND SPORTS OFFICIALS IN THE CONTEMPORARY BULGARIAN SOCIETY

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ABSTRACT
Sport is a mirror of the culture in which it develops, therefore analyzing the problems and trends in sport we have the opportunity to see a simplified model of society itself.
The subject of our study is to understand how much our society is a subject of a gender stereotypes and to which extent contemporary women and men are free to express themselves in any public sphere of their choice. The case with sports officials sheds light on this problem.
In the period May 2021 - January 2022, we conducted a study, within the international project Raising the growth and participation of female sports officials in Europe (WINS Project), supported by the Erasmus + Sport program, on the state and attitudes of Bulgarian sports officials, in all sports. We noticed several facts, typical for the modern Bulgarian society:

- *Bulgarian women do not suffer from strong gender stereotypes regarding what is a "male" or a "female" occupation. However, we notice a low level of involvement of women as officials in "men's sports", such as football, boxing and taekwondo and very high in "women's sports": almost 99% in rhythmic gymnastics. Yet there is a positive trend in terms of women's involvement in "men's" sports. There has been an increase in recent years of women officials in sports such as taekwondo, boxing, football, weightlifting, but we are still very far from the desired equality.*
- *Bulgarian women occupy a large part of the low-level sport officials' positions in athletics, but there are few women occupying higher positions and women also have lower salaries.*
- *In sports refereeing there are no legal differences that give privileges to one or the other sex, but this "equality" in some cases harms women who, due to motherhood or various ailments, have specific needs and requirements for working hours and work environment.*

Keywords: *Philosophy of Sports, Sports Management, Sports Officials, Gender Stereotypes, Inequalities*

INTRODUCTION

Female officials in Bulgaria are more common in typically female sports, for example, according to the rhythmic gymnastics federation, there are 155 female referees and no men; in aerobics, there are 49 registered referees, and only 4 of them are men. In artistic/synchronized swimming there are two female referees and no men. At the same time, in sports popular among men, the so-called "men's sports" have significantly more male referees. For example, in football there are 3 female referees and 131 registered male referees; in taekwondo ITF – 26 men and 8 women. In Bulgarian boxing, there are 5 females sport officials out of a total of 49 registered, and it is despite the fact that the only gold medal in boxing for Bulgaria belongs to Stoika Krasteva who won gold Olympic medal at the Olympic Games in Tokyo 2020. In chess, there are 9 women out of 36 men. However, in tennis, which is very popular among women in Bulgaria, there are 5 women and 4 men.

It is noteworthy that the more the sport is practiced by women, the more women are represented in management and refereeing. Bulgarian sport is highly feminized, in the sense that in the last 20 years most gold medals at the Olympic Games have been won by female athletes. At the latest Olympics in Tokyo 2020, women won medals in "men's" sports such as boxing, karate-do, shooting, but also in the "women's" rhythmic gymnastics. Since 2001 the management of sports in BOC (Bulgarian Olympic Committee) has also been under the female leadership of Stefka Kostadinova, Yordanka Blagoeva, Vanya Gesheva, Zdravka Yordanova, Maria Grozdeva, and Tanya Bogomilova.

However, it is difficult to explain the obvious inequalities that exist in sports refereeing in Bulgaria. We can say that the binary model in sports refereeing is common in Bulgaria. Gender stereotypes are especially reinforced in rhythmic gymnastics and synchronized swimming, where men are not well accepted either as sport officials or competitors, although these sports are already practiced by men as well (Gancheva, 2020).

There is a positive outlook on sports that are practiced equally by men and women. According to our research, in these sports, the binary model and dominance of one or the other sport is not so strongly presented.

METHODS

For 16 months (May 2021-June 2022) we conducted statistical research (survey processed in Excel); in-depth interviews with 10 international-level sports officials with great expertise; and an overview of normative documents and academic papers in the field.

The survey was standardized by Tom Webb for the needs of the WinS project *Rising the growth and participation of female sports officials in Europe*, part of the Erasmus+ Program, funded by the European Commission, and was implemented in Bulgaria, Belgium, Nederland, Great Britain, and France. In this report, we have included the data from Bulgaria. In the study, 98 active female referees from various sports in Bulgaria took part.

The age group of the participants varies, but girls and young professionals predominating.

Table 1. *Age and work experience of the examined persons*

percentages	**age group**	percentages	**work experience**
24.5%	25-34 years old	25.5%	3-5 years
23.5%	18-24 years old	19.4%	6- 10 years
21.4%	35-44 years old	18.4%	Less than 2 years
18.4%	35-44 years old	17.3%	16-20 years
8.2%	45-55 years old	11.2%	11-15 years
3.1%	65 +	8.2%	21+
1%	Under 18 years	-	-

According to our survey, the most female referees who completed our survey are involved in athletics 27.3 %, the second represented group are involved in Taekwondo – 12.2 %, female football referees are the third group – 13.3 %, followed by Gymnastics -7.1%, Archery 6.1%, and others. (Figure1).

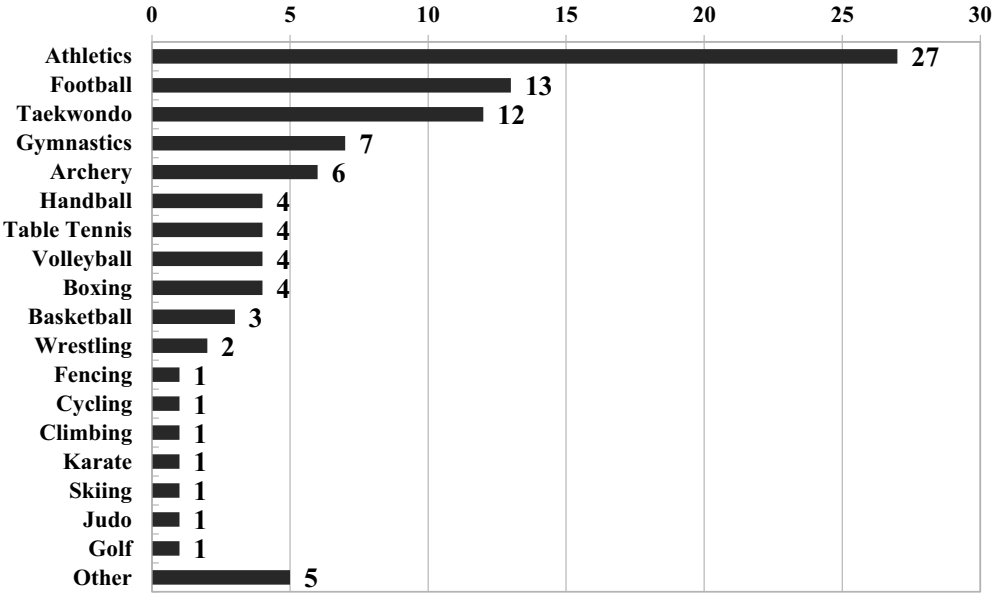

Figure 1. *Respondents by sport*

Most of them have decided to do sports refereeing because of their enthusiasm or passion towards the sport - 42.9 %, and the wish to remain in the sport after their sporting career is over – 26.9% and to be of use to the community 10.2% (Figure 2).

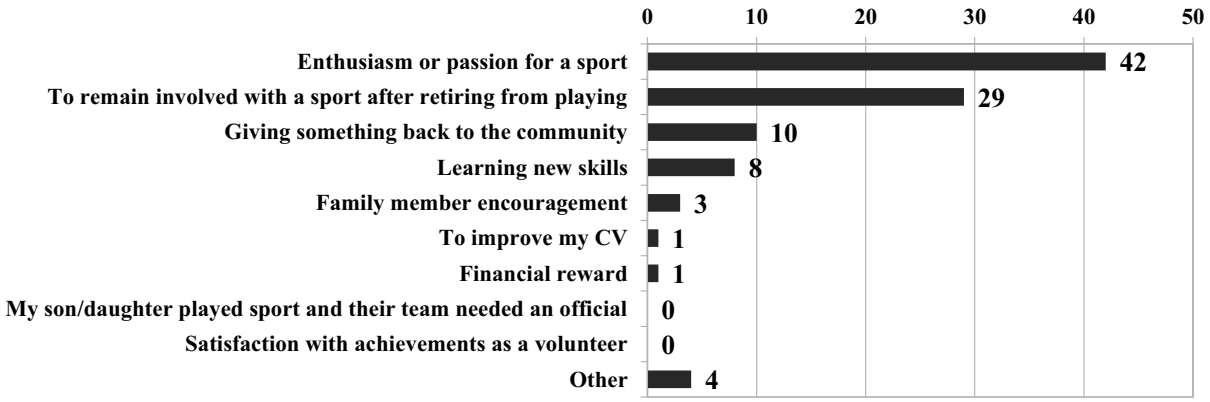

Figure 2. *What was the most important factor that made you decide to become a sports referee (referee, head referee, referee committee member, etc.)?*

RESULTS

It is noteworthy that in these sports the ratio between men and women is near to equal, according to 38.8% of examined persons, thus we are not so far away from the 50/50 equality because 55.1% of the respondents consider that men outnumber women (Figure 3).

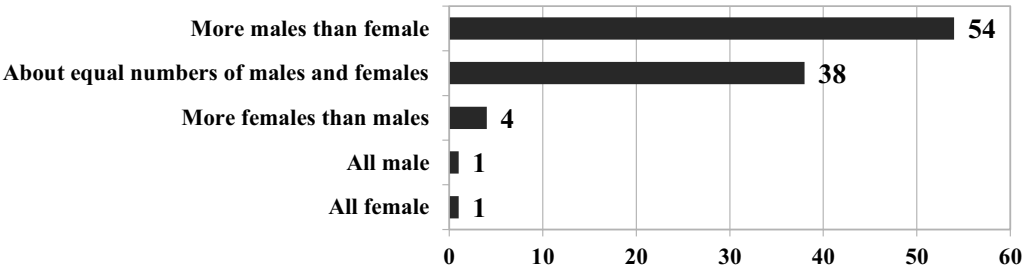

Figure 3. *Perceived ratio between male and female officials in their organization*

An undeniably positive trend is that, according to the interviewed female referees, 57.1 % of them, absolutely agree that women have equal access and only 6.1 % think that they don't have equal access with men. (Figure 4).

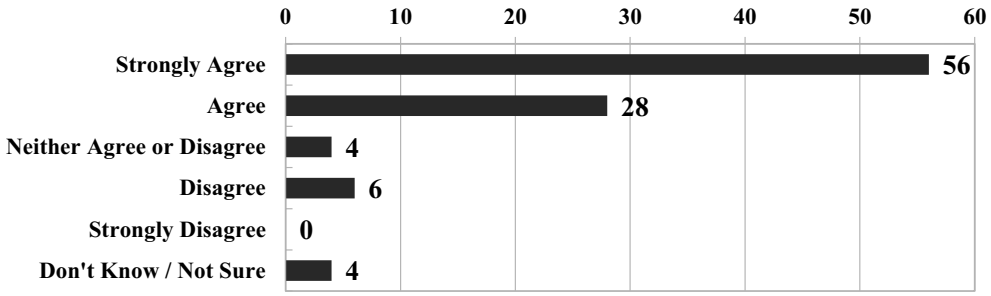

Figure 4. *Access to training opportunities are equal for female and male sports officials*

The majority of women referees feel that their sports organization treats them equally with men, 42.2 % of the women absolutely agree, 27.6 agree, only 8.2% disagree and 3.1% absolutely disagree. (Figure 5).

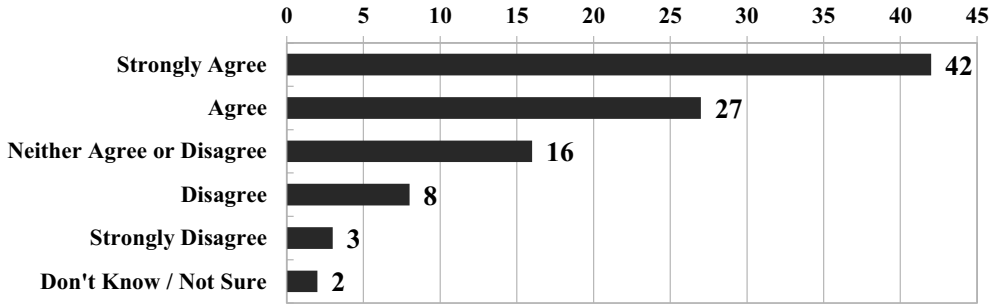

Figure 5. *My organization treats me the same as men*

However, female sports referees are not convinced that they are equal to men in their sports. 29.9% neither agree nor disagree, 23.3% absolutely feel equal to the men, 22.4 agree that are equal to the men, only 6.1% absolutely disagree and 8.2 disagree. However, there is more hesitation on this issue, because another 10.1% are not sure. (Figure 6).

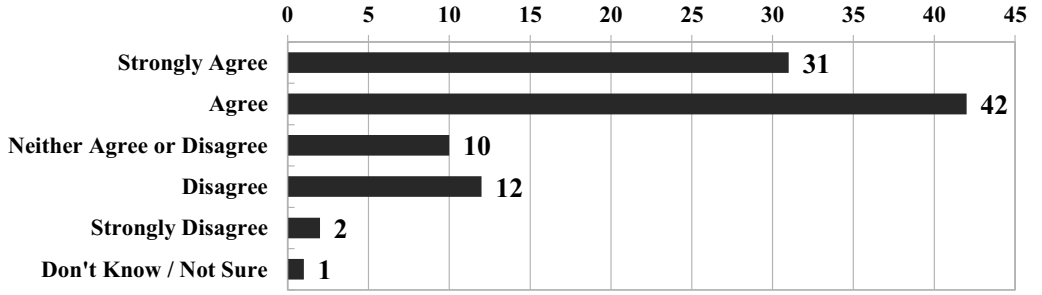

Figure 6. *I am provided with adequate support as a female judge*

Sports referees are often criticized and subjected to aggression from the public. It gives a positive impression that our respondents are not treated completely differently by the audience; 43.3% don't think that the audience is more aggressive toward them because of their gender but 45.9 feel that the public has a special attitude toward them because they are female.

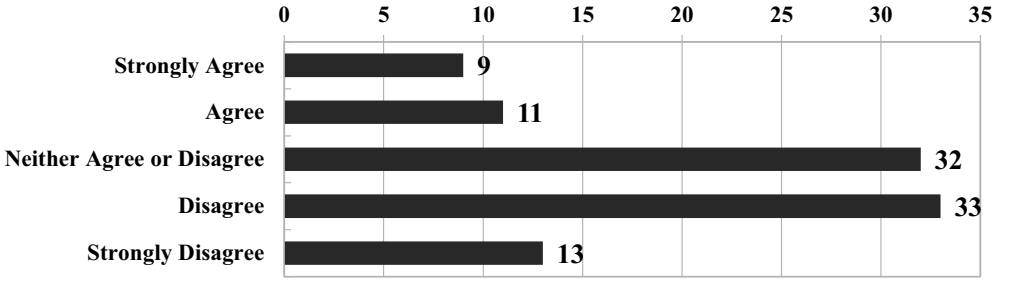

Figure 7. *Abuse is different towards you as a female official compared to male officials*

In Bulgaria, the rules for selecting sports referees are the same for men and women. This model has been imported and unified for the whole world. For example, Bulgaria is part of the Association of Balkan Athletics Federations and World Athletics and shares the regulatory international rules. There are no specially developed rules for women in Bulgaria. Women must meet the same requirements as men. This applies to female referees, but female athletes must follow specific gender-based rules. This shows that at the level of refereeing there is no difference between the sexes, even though the sports themselves are divided according to the different abilities and norms that men and women have to cover. It follows that strength, speed, and endurance have no bearing on refereeing, but this raises

the question of why there are significantly fewer women than men, and this is particularly the case at the higher levels of international refereeing. This also affects payment. Refereeing in athletics, for example, is considered a volunteer job because there is no fixed salary, but daily expenses, hotel, food, drink, etc. are covered, and therefore they are paid for in a different way. Women are often excluded from this life of "traveling elites" because they are either unable to travel because of domestic responsibilities or the well-paid positions are held by men. According to our in-depth interviews, women referees in football feel ridiculous in male referee uniforms. A particular problem and mockery are created by the front pocket of the uniform, which for women coincides with their chest. Female soccer referees said they don't have the same equipment as men and this statement is supported by our survey. When asked if female sports referees are given the same equipment as men, 33.7%, 32.7 are not sure, 13.3 strongly disagree, only 9.2% absolutely agree, and 11.2 agree.

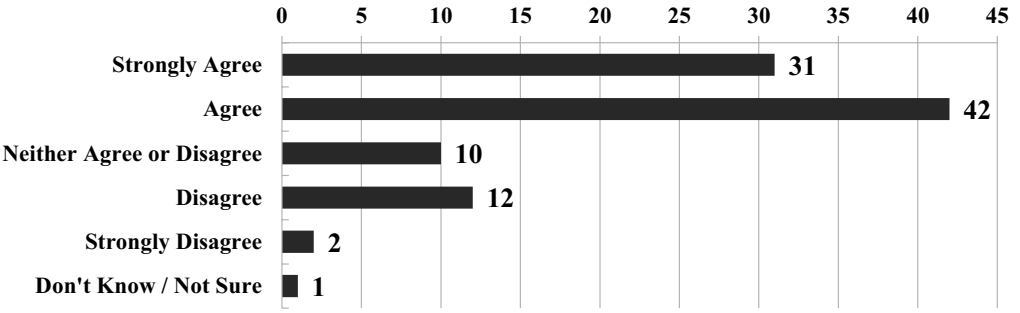

Figure 8. *Do you receive an adequate support as a female judge*

An important factor is how sports officials are perceived by the contestants and the audience. According to interviews conducted for the purposes of this study with female referees in athletics, football, and taekwondo, public attitudes toward them vary. Women referees are not very well accepted in football. They most often have problems with the players who do not accept their decisions, but also with the public who do not accept that a woman can "understand, and even judge in football". For women, it becomes even more difficult to impose themselves in this sport, because the very role of the football referee is to be among the most hated on the field, regardless of his/her gender.

Female sports officials in athletics and taekwondo do not think they are perceived differently from men. A problem for them, for example, is that they don't have enough breaks to nurse their babies, and they don't have designated places to swaddle them and pay attention to them. In general, it is almost impossible to combine a child and a job, even though a sports official in Bulgaria is in many respects considered a part-time job. Sports officials often have to bring their children with them because competitions are usually held on weekends. Female referees with small children have a serious problem in practicing their profession because the competitions are held in different cities and countries, and this implies more frequent absence from home, which in many cases is impossible for them and accordingly makes it difficult for them to realize themselves as sports referees and grow in the sports official's hierarchy. In this regard, the community of referees is of particular importance. In athletics, friendship groups are established where women, men, and their children are accepted and looked after by the community. While the mother judges or competes, the running community makes a commitment to look after her children, "as their own". According to our survey 29.6% are not sure that parental responsibilities are duly taken into account (we should keep in mind that more of them are too young and don't have children yet), 23.5% absolutely agree, 22.4% agree and only 6.1% absolutely disagree and 8.2% disagree.

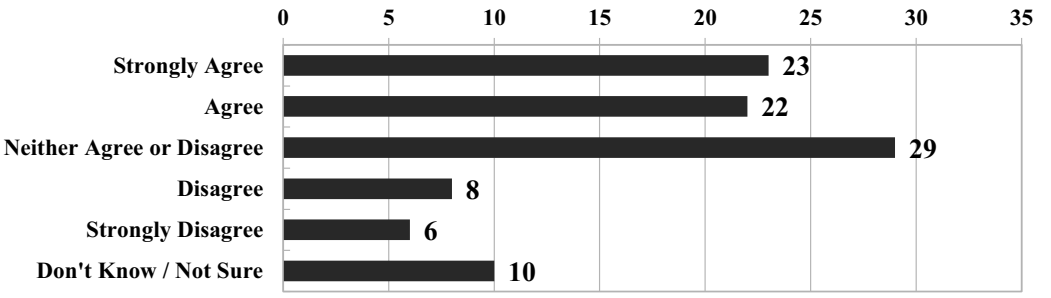

Figure 9. *In my sport, parental responsibilities are duly taken into account*

DISCUSSION

Despite the good examples, in men's sports, the attitude towards women is rather negative and this is a fact on a European level. Tom Webb (Webb et al., 2021) in a study of international female sports officials in football, published results according to which women were forced to work in a toxic, abusive, male-dominated environment that includes sexist, degrading, and humiliating language. This affected negatively their mental health. Sports Officials' colleges were fighting against this attitude, but Webb recommended having educational courses in local organizations that provide information or training on mental health, because female sports officials are often, due to the nature of their work and the hostile environment, in poor mental health. during and after matches. According to his research, there is a need for a greater commitment to mental health literacy and policy has to be changed by governing bodies.

Similar conclusions were reached by the Bulgarian researchers Hristova and Krumova (2020). According to them, positive attitudes towards sports depend on public image and continuity. Of particular importance are the good examples of athletes who are role models. Regarding refereeing, we have a problem because if there are good female athletes in Bulgaria thanks to the good role models of the previous generations of female athletes, the anonymity of the refereeing profession and the lack of enough women as examples in this field does not motivate female athletes and sports fans to take up this profession. In Bulgaria, there is a prejudice against the ruling representatives of power (Naydenova, 2019) and this makes the choice of the woman, who is already burdened by stereotypes, even more difficult.

However, according to our research, women referees do not suffer from gender stereotypes and feel fulfilled and supported in the sports in which they find recognition and support. The problems they point out (low payment and not so good work environment) are not a private problem of women, but also of men. In this regard, we can say that female sports officials are equal to male referees, especially in sports that are practiced by both sexes.

In this regard, it is appropriate to note that the majority of the persons studied are track and field athletes, where, in general, women and men have equal representation. Also, many of them are young, and do not yet have families and children, therefore the answers to the questions related to work and family obligations are based on guesswork and not on personal experience.

However, we can be proud that the majority of the growing generation of Bulgarian sports referees does not suffer from gender stereotypes.

ACKNOWLEDGMENTS

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REFERENCES

Gancheva, G. (2020). Prouchvane varhu hudozhestvenata gimnastika za mazhe. *Godishnik na NSA*,

Vol. 2 // Ганчева, Г. (2020). Проучване върху художествената гимнастика за мъже. *Годишник на НСА*, бр. 2

Hristova, P., Krumova, A. (2020). Faktori, obuslavyashti pozitivnite naglasi kam sporta pri sportuvashti yunoshi. *Savremenni tendentsii na fizicheskoto vazpitanie i sporta*, Vol.1, pp 357-366. / Христова, П., Крумова, А. (2020). Фактори, обуславящи позитивните нагласи към спорта при спортуващи юноши. *Съвременни тенденции на физическото възпитание и спорта,* стр.357-366

Naydenova, V. (2019). Tsentrove za otsenka i razvitie – podgotovka i osashtestvyavane v organizatsionen kontekst. *Godishnik na Sofiyski universitet. Vol. Psihologia*, No 109, pp. 229-247 / Найденова, В. (2019): Центрове за оценка и развитие – подготовка и осъществяване в организационен контекст. В: *Годишник на Софийски университет. Книга Психология*. Том 109, София. Стр. 229-247

Sinigerova – Ilieva, Silvia, Mihail Konchev. (2021). Faktori na sluchayna sadiyska greshka v distsiplinata „forma" v taekuon-do ITF, *Godishnik na NSA*, Vol. 2, pp-34-46 /Синигерова – Илиева, Силвия, Михаил Кончев. Фактори на случайна съдийска грешка в дисциплината „форма" в таекуон-до ITF В: *Годишник на НСА*, том 2

Webb, T., Gorczynski, P., Oftadeh Moghadam, S. & Grubb, L. (2021). *Experience and construction of mental health among English female football match officials*. The Sport Psychologist, Vol 3, pp. 17-25

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EVOLUTION OF TAEKWONDO FROM SPIRITUAL AND CULTURAL PRACTICE TO A MARTIAL SPORT

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ABSTRACT
The evolution and development of each system follow the dynamic pace of everyday life, technological progress, consumer's interests and needs satisfaction, adaptation to modern socio-economic conditions, and other important factors. The aim of the present study is to track peculiarities in the evolutionary development of taekwondo from spiritual and cultural practice to a martial art. The object of this study is the system of Taekwondo WT. The subject of our research are the stages in the development of Taekwondo WT, transformations in the legal framework of the World Taekwondo Federation, and some specific and essential aspects of the system. The evolutionary stages in the transformation of Taekwondo WT, proposed by the author, are part of a wider concept related to its institutionalization. Various literature sources and key documents of the World Taekwondo Federation from different periods of the system were studied through the application of content analysis. The results indicate that Taekwondo WT is a system with a wide range and consumer interest. The inclusion of WT taekwondo as a major sport in the Olympic Games not only attracts more users, but also leads to dynamic transformations in the legal framework of the World Federation, to the implementation of technical devices to increase objectivity in competitions and to the launch of new products and services. In addition, different approaches are being adapted to increase the audience's interest in WT taekwondo events, as well as different practices by sport clubs are being applied to meet the needs of the consumers. The reviewed WT taekwondo system, its current state and stages of development, clearly outline a departure from the ancient ideology and philosophy of the martial arts at the expense of a global scale and scope, leading to today's typical goals - segmentation, meeting different consumer needs, achieving high sports results, more people involved, easy accessibility, etc.

Keywords*: sport, taekwondo, evolution, martial arts*

INTRODUCTION

The problem of the study is the inducted transformation on a management and functional level at the Taekwondo system as a result of the evolution from spiritual and cultural practice to a martial sport, which problem is currently poorly researched and analyzed. The ignorance of the processes is a challenge to the traditional sports practices facing the modern management. The aim of the present study is to track peculiarities in the evolutionary development of Taekwondo from spiritual and cultural practice to a martial art. The object of this study is the system of Taekwondo WT. The subject of our research are the stages in the development of Taekwondo WT, transformations in the legal framework of the World Taekwondo Federation and some specific and essential aspects of the system. The evolutionary stages in the transformation of Taekwondo WT, proposed by the author, are part of a wider concept related to its institutionalization.

In order to study and get to know the processes in the development of Taekwondo WT as a system, it is necessary to get acquainted with the main moments in its history (Draganov, 2015). After performing an analysis of literary sources, we can summarize several historical views related to theories about the origin and development of Taekwondo, as well as the trends that influenced it. One of the main issues faced by a number of authors is whether Taekwondo is a traditional Korean martial art or one that was formed as a result of influences from other Asian cultures. D. Avramov (2012) claims that in the process of its development, Taekwondo underwent many changes and was called by different names.

METHODOLOGY

The content analysis is a research tool related to the empirical humanities and social science framework used for analyzing text in various formats. The method differs from the well-known statistic quantitative analysis by qualitative research of the subject of the study. By the content analysis method has been researched available sources of information relevant to the study. The inclusion criteria for the research were sources related to the problems of the development and management of Taekwondo on a global aspect. The sources vary between: Bulgarian and foreign languages materials, dissertations, encyclopedias, journals, internet and others. The application of the method requires research and analysis of targeted information, related to the current problem.

The presented innovative review of the evolution of Taekwondo from spiritual and cultural practice to a martial sport is part of a wider concept, related to the optimization of the management of its system. To draw this concept, we researched and analyzed 140 sources, 58 in Cyrillic and 82 in English. For the current study, we focus on a limited part of them – 12 sources.

RESULTS

The analysis of the study's results differs several periods at the evolution of Taekwondo from spiritual and cultural practice to a martial sport, part of the international Olympic movement. The research method we choose requires a retrospective review of the specification of each stage. To reach the purpose of the study is needed to track the development of Taekwondo and its management. Base on that at the end of the analysis of the results we are proposing three author's evolutionary stages.

A major historical aspect is the perception that Taekwondo is a martial art that has preserved the traditions of ancient Korean martial systems passed down through generations. Wall paintings, statues, ancient literary sources, frescoes and other discoveries of archaeological activities are used as a basis for these claims. During the 6th century, a special group was formed. It relied on a moral and ethical code - personal discipline, humanity, morality, religion, service to the country, etc. The unit was called the Hua(l)ang "the brilliant knights of the Silla dynasty" (Green, 2001). According to H. Yeon and J. Gerrard (2000), Huarang members had exceptional knowledge in social, religious, medical and other fields. Along with performing their main tasks, the Huarang also presented fun games to the public. Elements of one of these games – Taekkyon resonates with Taekwondo. The goal of the game is to maintain balance and knock the opponent down on the ground using only leg techniques. Another martial art associated with the origin of Taekwondo is Subak. Translated it means "fighting techniques with hands". In support of the thesis about the ancient origin of Taekwondo, it is written that it is the product of years of traditions and transformation of Sunbae (from the time of the Goguryeo kingdom), Subak (Goryeo kingdom) and Taekkyon, introduced at the end of the Chosun Dynasty. Due to the limited access to reliable literary sources, we, as well as other researchers, do not have the opportunity to establish the sustainability of the thesis that Taekwondo originated from the ancient Korean martial arts.

Another theory about the origin of Taekwondo is related to the personality of a general Choi Hong Hee, who is said to have created the martial art. According to A. Franks (Choi, 1983), supported by A. Asenov (1998), general Choi has been developing and eventually created Taekwondo since the beginning of 1946. The author also writes that the basis of Taekwondo is connected to the ancient history of Korea, which confirms the first theory presented. Choi writes that "a combination of circumstances allowed me to create and develop Taekwondo." The general practiced Taekkyon as a child, after which he devoted himself to Karate. The idea, crediting the sole creation of the martial art of Taekwondo by Gen. Choi Hong Hee, is mainly supported by the members and supporters of the International Taekwondo Federation (ITF). Continuing his studies, the Korean citizen Choi went to Japan in 1937, where he was trained in the Japanese martial art of Karate. In 1946, he joined the South Korean army. There, he was given the opportunity and access to train some soldiers in Karate techniques. In September 1954, through an impressive demonstration, he attracted the attention of Korean President Syngman Rhee, who assisted Choi Hong Hee in enforcing and popularizing martial arts nationally. After the political and military processes on the Korean Peninsula in the 1940s, citizens gain the right to freely access and practice combat sports - a privilege, reserved only for the military before the change of the regime in the country. The different approaches applied in Korean martial schools led to a desire to standardize and unify them. At the initiative of President Syngman Rhee, a Naming Committee was convened to select and ratify the name "Taekwondo" as the name of the Korean martial art. In 1959, the Korean Taekwondo Association was founded with the first president, Gen. Choi Hong Hee. Historical facts show that gen. Choi Hong Hee played a major role in naming the Korean martial art Taekwondo. He was the president of the first licensed organization for the development of Taekwondo, but is that enough to claim that he created the martial art? According to Willy Pieter, the name Taekwondo is not associated with creating a new fighting system, but with renaming an old one with a more appropriate name (Piet-

er, 2009). Another theory regarding the historical development of Taekwondo is related to the first profiled fighting schools in Korea. According to D. Cook (2001), schools (kwans) emerged as one of the ways to restore the national identity, and the tool to achieve this was martial arts. Coaches in the kwans were Koreans who had acquired skills in Japanese and Chinese martial arts. One of them was General Choi Hong Hee. The fact that most of the masters who founded schools acquired their skills in Japan strongly suggests that the teaching methods and overall organization in the Korean clubs were influenced by the Japanese model. Karate skills or Tang Su Do, as the Koreans called it (Korean Karate) were widely practiced in the kwans (Gillis, 2008). The researched data, regarding the martial schools formed in the period 1944-1956, allows us to interpret that these organizations were the founders in the development of martial arts in Korea after the change in the political climate in the country. Also, key martial arts schools in Korea signed a Declaration of Unification in 1978, confirming that Taekwondo would be practiced in the clubs.

There is a theory with quite a few followers that explores the foundations of Taekwondo in the Japanese martial art of Karate. The claims are formed on a factual basis that during the Japanese annexation, a ban was imposed on the practice of Korean martial arts. Another main line that follows the theory and which has been laid out earlier in our work is that most of the early kwan masters trained Karate. Supporters of the theory find similarities between the two martial arts both in the strikes and in the structure and movements in the forms - a system of blocks, punches and kicks executed in a strict sequence. The term used for a profiled fighting school "Kwan" corresponds to the name of the first Karate school - Shotokan (in Korean Song-do-kwan). W. Kang and K. Lee (1999) summarize that all martial arts currently practiced in Korea are either Japanese or Chinese, with the exception of Taekwondo. In his works, Song Hyeong-sok claims that we can connect the root of Taekwondo with Karate, but in its development, the Korean martial art builds its own identity and uniqueness. Applying the retrospective approach, we find quite a few similarities between Karate and Taekwondo. We can find them in the uniforms used for training, we find them in the system of technique used for blocking, punching, striking, and kicking. We can also find them in the terminology of the techniques and more. Investigating the theory of the origin of Taekwondo from Japanese Karate, numerous data are found that confirm the claims historically, chronologically, and factually.

In the several possibilities presented so far regarding the origin, foundations, and development of Taekwondo, we believe that there are unexplained circumstances that cast doubt on the actual events. In order to establish the historical veracity, in-depth analysis and research of reliable sources are required to cover the period of the Three Kingdoms to the institutionalization of Taekwondo.

In the last 60 years, Taekwondo has gained wide popularity on an international scale. This is due both to the institutions that develop and popularize the martial art, and to modern marketing methods for imposing products and services on consumers. From an institutional point of view, there are two main organizations administering and promoting Taekwondo globally - the International Taekwondo Federation, established in 1966, and the World Taekwondo Federation, established in 1973. The views and policies in the organizations differentiate between two styles in Taekwondo – ITF and WT(F). As we noted earlier, the present paper traces the processes in Taekwondo WT.

In the early 1970s, the Korean government realized the potential of Taekwondo as a sport that could promote the perception of Korean culture around the world (Moeing, Kim, 2019). The World Taekwondo Federation and its then president Kim Un-yong were charged with the task of establishing Taekwondo as a modern sport expressed in all its manifestations – sports for all, amateur and professional, timely accessible to a wide range of socio-economic groups. Kim's personal contacts and diplomacy, as well as the institutional intervention of the Korean Olympic Committee and other organizations, facilitated the inclusion of WT Taekwondo as a demonstration sport at the 1988 Olympic Games in Seoul, Korea. After the Games in Seoul, this Korean martial art was included as a demonstration in 1992 at the Olympic Games in Barcelona. At a meeting of the IOC in 1994, held in Paris, Taekwondo WT was accepted as an official sport for the Sydney Olympic Games in 2000. On 03.02.2022, another decision confirmed the inclusion of the sport until the Olympic Games in Los

Angeles 2028 (World Taekwondo, 2022). From the initial official inclusion of WT Taekwondo in the Olympic Games until today, the World Taekwondo Federation has faced significant challenges in maintaining the status of an Olympic sport. The need to prepare clear and transparent criteria for the selection of participants in the Olympic Games and the updating of the sports competition rules and regulations are fragments of the normative transformations accompanying the World Taekwondo. New structural units have been formed, commissions and directorates profiled towards specific activities, and tasks are established to achieve the goals of the Federation related to the recommendations of the IOC and the global sports movement. The organization implements campaigns for large-scale promotion of Taekwondo WT, relating to the assertion of its identity, uniqueness, and recognizability. WT is constantly striving to expand the international contact network, membership and the attraction of different socio-demographic groups.

Based on the above challenges and aspects of the development of Taekwondo WT, we present several authorial evolutionary periods that contribute to a clearer understanding of the Korean martial art system and Olympic sport:

- From the creation of the World Federation to the inclusion of Taekwondo WT as an official sport in the Olympic Games (1973 – 1994);
- From the adoption of Taekwondo WT as an official sport to the Olympic Games in Beijing (1994 – 2008);
- From the Olympic Games in Beijing to today (2008 -)

The first evolutionary stage of the Taekwondo WT system, as we explained above, we associate with intensive development at the institutional level. Sports-competition standards are enforced, a large personnel and financial resource is activated in order to include Taekwondo WT as a part of the Olympic Movement. The aspiration for mass popularization of the martial art is distinguished.

In the second stage, Taekwondo WT reaches higher levels of national popularity. The members of the continental unions are increased, and with it the practitioners of the sport. Regional, international and national tournaments and championships are organized with a large number of participants. In the period 1994-2008, the sports and competition rules were amended 4 times (World Taekwondo, 2022) in order to optimize the competition conditions. Improvements in sports equipment, changes in match duration, and the use of technical equipment by officials during competitions are reported. The expansive development of the sport and its wide practice creates prerequisites for the discovery of a large market niche related to increasing the technical degrees of the trainers in schools and other services aimed at mass consumers. The period covers three Olympic cycles, a time in which the first Olympic champions appeared - Michail Mouroutsos (Greece), Steven López (USA), Hadi Saei (I.R. Iran), María del Rosario Espinoza (Mexico) and others. The first individual sponsorship contracts are signed. Popular athletes begin to advertise attributes and services of the WT Taekwondo system, the prerequisites for the development of a dual career are created.

The third evolutionary stage in which we find ourselves today is associated with the intensive technological progress of the 21st century, implemented in the Taekwondo WT system. In the years since 2008, different technical equipment and methods have been presented, aiming at the objective selection of winners in taekwondo competition. Since the Beijing Games, an electronic-sensored body protector has been introduced to automatically detect the force of an impact and validate a point if it meets the technical requirements. In 2009, an in-game video review system was introduced, allowing coaches of athletes to challenge refereeing decisions. During the Olympic Games in London 2012, the dimensions of the playing field were reduced from 10x10 m to 8x8 m, and in 2016 the square shape was replaced by an octagonal one - all this in order to increase the dynamics of the matches and improve mass recognition and Taekwondo WT identity. The point system has been changed several times over the years of the third stage. Updates encourage more headshots and body spins, resulting in more engaging encounters. In 2013, the electronic sensor head protector was introduced. It works identically to the body one. In line with the recommendations of the IOC at the Games in Brazil (2016), the World Taekwondo Federation implemented gender equality for the first time not only among competitors but also among officials. The refereeing panel is structured by 15 men and 15 women. 2018 introduces an innovative 4D approach for filming competition matches through

100 cameras, further reducing the possibility of refereeing errors. An evolutionary step in the development of Taekwondo WT from a legal-normative aspect is the administration and implementation of World and Olympic rankings. Rankings present the opportunity to directly win an Olympic quota or a more favorable draw in the competition forums. In addition to innovations and expanding the scope of the discipline Kyrougi (full contact combat sport), interest in the discipline Poomsae (form) is increasing. Various competition formats are required, allowing individual or team combination. During the COVID-19 pandemic, the competitive discipline quickly adapted to the current situation and evolved into holding online tournaments.

DISCUSSION

The above facts allow us to conclude that the Taekwondo WT martial art system has evolved into an Olympic combat sport, which brings its own specifics. The building of moral and ethical qualities and the affirmation of the personality give way to the creation of medalists from sports forums and holders of high technical degrees. However, the typical hierarchical structure of the institutions is preserved to this day. The modern global scale of Taekwondo WT covers a wide range of socio-demographic groups and representatives of regions with different economic opportunities. Access to WT Taekwondo System products and services today is facilitated and targeted to the individual interests of users. The transformational processes in the Taekwondo WT system and its institutions put the traditional principles of martial arts in the background before the modern trends in the development of the sport – more practitioners, satisfaction of needs, profit, spectacle and winning medals from elite competitions.

REFERENCES

Avramov, D. (2012). *Optimizirane na sistemata za povishavane na tehnicheskata stepen v Taekuondo i sazdavane na metodika za obuchenie,* Disertacia, Sofia, Bulgaria. // Аврамов, Д. (2012). *Оптимизиране на системата за повишаване на техническата степен в Таекуондо и създаване на методика за обучение*, Дисертация, София, България

Asenov, A. (1998). *Taekuondo,* NSA Pres, Sofia, Bulgaria. // Асенов, А. (1998). *Таекуондо*, НСА Прес, София, България

Choi, H. H. (1983). *Encyclopedia of Taekwondo*, Vol I, Soul, Korea.

Cook, D. (2001). *Taekwondo Ancient Wisdom for the Modern Warrior*, YMAA Publishing Center, Boston, Massachusetts, USA.

Draganov, G. (2015). Korporativnata socialna otgovornost – oshte edna vazmozhnost pred sporta. *Sport i nauka*, ES PRINT, Izvanreden broj 1, str. 3-12 // Драганов, Г. (2015). Корпоративната социална отговорност – още една възможност пред спорта. Спорт и наука, ЕС ПРИНТ, Извънреден брой 1, 3-12.

Green, T. A. (2001). *Martial arts of the World. Vol One: A-Q*, ABC-CLIO, Inc., Santa Barbara, California, USA.

Kang, W. S. and Lee, K. M. (1999). *A Modern History of Taekwondo, Bokyung Moonhwasa Seokyo-dong, Mapo-ku*, Seoul, Korea.

Pieter, W. (2009). Historical aspects of t'aekwŏndo, Achieves of Budo, Volume 5, pp. 97-101.

Moeing, U. and Kim, M. (2019). The Japanese and Korean Martial Arts: In Search of a Philosophical Framework Compatible to History, *The International Journal of the History of Sport*, Volume 35, pp. 1531-1554.

World Taekwondo. (2022). *Competition Rules and Interpretations,* Seoul, Korea.

Yeon H. P. & Gerrard, J. (2000). *Black Belt Tae Kwon Do,* Skyhorse Publishing.

World Taekwondo. (2022, February 3). Taekwondo confirmed for LA 2028, available at: http://www.worldtaekwondo.org/wtnews/view.html?nid=138685 (accessed 29 June 2022).

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