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ORIGINAL ARTICLE

The effect of plyometric training on performance levels of the shot put technique and its related motor abilities

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Purpose: The aim of this research is to evaluate the effects of plyometric training on the shot put technique. It was oriented to improve the basics for the development of power related-indicators such as power (explosive force), acceleration speed, and strength endurance.

Material: The study sample included 220 male students, aged 16 years ± 6 months from Fehmi Lladrovci High School, Glogoc municipality, Republic of Kosovo from the 2019/2020 academic year. The experimental group (110 male students) applied a 12-week program (see the training program paragraph). The control group (110 male students) continued only with their regular physical education lessons (2 times a week). To determine the differences between pre- and post-test values of the control and experimental groups ANOVA calculations were made. The development percentage in time (between pre-test and post-test) were calculated using the formula: Δ% = (x post-test – x pre-test) / pre-test *100.

Results: Results of the study show that pre- and post-test average values (tests within subjects) of the shot put technique ($p<0.05$) were statistically different according to measurement over time (interaction; $p<0.05$), and in tests between the subjects ($p<0.05$). The shot put technique (Δ%: 50.88) test of the experimental group (plyo-training) had higher developmental percentages compared to (Δ%: 1.69) the control group ($p<0.05$). When analyzing the developmental percentage, it was observed that the performance of the shot put technique of the experimental group compared the control group 49.2% more developed. Furthermore, the impact of the plyometric training program in motor abilities related to the shot put technique also observed similar improvements in the impact of the shot put technique.

Conclusions: In conclusion, the impact of the plyometric training program on motor abilities related to the shot put technique also observed similar results as the training program's impact on the shot put technique. The applied plyometric training program benefits were not just in the shot put technique but also improved all motor abilities related to the shot put technique such as power, strength endurance, speed and acceleration. Therefore, the development of the shot put technique occurred by an increase in motor abilities related to the shot put technique as a result of the plyometric training program.

Keywords: shot-put technique, plyometric training, power (explosive force), acceleration speed, strength endurance

Introduction

Athletics is an exclusive collection of sporting events that include races in running, jumping, throwing and walking. The most common types of athletics competitions take place on sports fields and also include street jogging, sports walking races, etc. Athletics is primarily an individual sport, with the exception of relay races and competitions, which combine team performance of athletes, or athlete scores, such as in cross-country [1].

Shot put is one of the four disciplines that are part of athletics throwing along with the discus throw, hammer throw and javelin. The shot put is an athletic throwing event that involves putting, or pushing, a heavy metal ball with one hand as far as possible. Shot putters use their strong quadriceps, hamstrings and gluteus maximus muscles to push off from the back of the circle and generate the initial thrust necessary to get the heavy metal shot moving across the circle.

Throwing involves an exact shot put technique based on explosive actions such as short sprinting, jumping, weightlifting, etc. Plyometric exercises are mainly used to increase maximum energy production and the ability to jump. Plyometric training programs include training loads with a number of jumps and intervals between sets of exercises and drills. In plyometric exercises, athletes perform various explosive actions, which help to improve their skills [2, 3].

Depending on the effect on the neuromuscular system and their biomechanical structure, trainers have categorized strength-training exercises for throwers as general or specific [4, 5]. General exercises are those that aim to build a foundation by increasing maximum strength in specific muscles, especially the main movers, regardless of the range of motion, joint angle, or speed that may occur in the current event [6].

Performance on track and field throwing competitions depends to a large extent on the production of muscle power. Muscle power is a product of strength and speed, so each or both of these ingredients, should be addressed in a training program to develop muscle power. Both

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groups of athletes, beginners and elite throwers, spend a great deal of their preparation using conventional power training or various forms of energy training to increase muscular power and throwing performance. For beginner and intermediate-trained throwers, resistance training causes a significant increase in shot put performance [7].

Although, shot put is a dynamic event demanding high power production, one of the parameters that determines the power production of a muscle group (whole-body), is muscular strength. However, the relationship between strength and shot put performance has not been thoroughly examined [8]. In light of this information, we think that the shot put technique and its related factors should be examined in more detail. The aim of this research is to evaluate the effects of plyometric training on the shot put technique. It was oriented to improve the basics for the development of power related-indicators such as power (explosive force), acceleration speed, and strength endurance.

Material and Methods

Participants

The study sample included 220 male students, aged 16 years ± 6 months from Fehmi Lladrovci High School, Glogoc municipality, Republic of Kosovo from the 2019/2020 academic year. The experimental group (110 male students) applied a 12-week program (see the training program paragraph). The control group (110 male students) continued only with their regular physical education lessons (2 times a week).

The study was conducted in a manner that respected the principles established by the Declaration of Helsinki and it was approved by the Ethics Committee of the University.

In the study, data collection tools were as folows. Countermovement jump (CMJ), Standing broad jump (SBJ), Tipple standing jump (TSJ), Standing medicine ball throw (SMBTH), 10 Meters run (10mRUN), 20 Meters run (20mRUN), Plate tapping (PLT), Foot-tapping against the wall (FTAW), Sit-ups in 30 sec (SUP30s), Push-ups in 30 sec (PU30s), Dips (D), Flamingo balance test (FB), and Performance levels of the shot-put technique.

Testing Procedures

Subjects were assessed before and after 12 weeks of the plyometric training program, all measurements were taken before the start of the training and after the end of the training. The tests were preceded by a general warm-up. Countermovement Jump (CMJ) was performed on a contact mat platform [9]. Standing Broad Jump (SBJ) and Standing Triple Jump (STJ) measurements were conducted according to the Nešić Protocol [10]. Standing medicine ball throw (SMBTH) is a test for assessment of explosiveness of the shoulder area (the results were obtained with an accuracy of 1 cm) [10]. 10-meter and 20-meter sprint test measurements were performed according to the Bjelica and Fratrić protocols (the result is given with an accuracy of 0.1 sec) [11]. Plate tapping (PLT) and foot-tapping against the wall (FTW) were used to measure movement speed individually and measured according to the standard procedure used in the euro-fit test battery [12]. The sit-ups in 30 sec (SUP30s) test measured by bending the elbows from the straight position, then approaching the ground and straightening the elbows again; correctly done and completed sit-ups were counted and recorded [13]. Push-ups in 30 sec (PU30s) have validity and reliability [14] to measure the muscular strength endurance of the chest and back arm muscles [14, 15]. General body balance was used by the Flamingo Balance (FLB). A metal beam 50 cm long, 4 cm high, and 3 cm wide were used in this test. During this test, the subject tries to maintain his posture like a flamingo for a long time by standing on the metal beam. For 1 minute, any intervention (that does not fall) made to maintain balance in the beam is considered as a point. The dips (D) test was performed in parallel for men placed in the gym. The subject is placed with support in the hands at the beginning of the parallel bars, with straight legs hanging down. The task of the test holder is from the position described above, as much as possible to perform parallel lifts. The maximum number of parallel rises is estimated. At the moment of ascent, the arms must be completely straight, respectively gathered during the phase of falling on the support. At the same time, the legs are straight. [16].

Training Program

The plyometric training program was prepared according to the National Strength and Conditioning Association (NSCA). The volume of the training varied between 85-120 contacts per session, intensity varied between low to high load and was applied 3-4 times per week (fig. 1). Bounding drills normally covered distances greater than 98 feet (30 m) or work time approximately

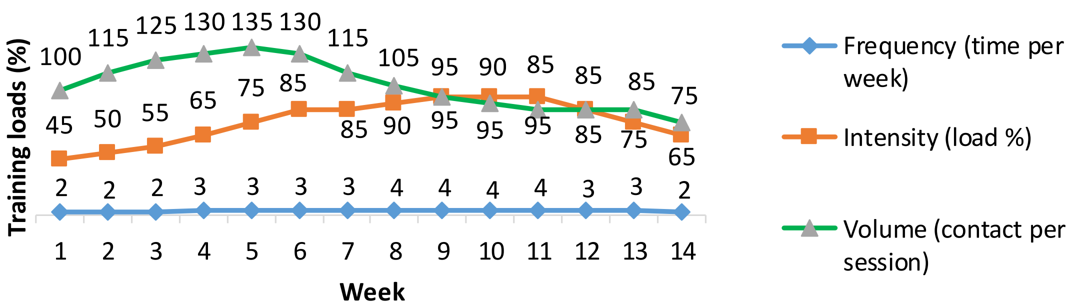

Figure 1. Plyometric training program loads

20-25 sec, and box jumps were repeated 10-15 times. Recovery for depth jumps consisted of 5 to 10 seconds of rest between repetitions and 2 to 3 minutes between sets. The time between sets was determined by a proper work-to-rest ratio (i.e., 1:5 to 1:10) and was specific to the volume and type of drill being performed (tabl. 1).

For safety considerations, athletes who were more than 100 kg were not requested to lift 1 RM squat minimum of 1.5 times his or her body weight, and to stand on one leg for 30 seconds without falling, and were not included in the plyometric training (tabl. 1).

When the training intensity in the lower extremities was low, moderate and low-severity exercises were applied in the trunk and upper body (fig. 2). The same rule applied when working with other parts of the body.

Statistical Analysis.

IBM SPSS Statistics 24 software was used for data analysis. To determine the differences between pre and post-test values of the control and experimental groups, ANOVA calculations were made. The development percentage in time (between pre-test and post-test) were calculated by using the formula "%Δ = (x post-test – x pre-test) / pre-test *100" where the confidence interval was chosen as 95% and values below p <0.05 were considered statistically significant.

Results

According to the results of Table 2, it was observed that pre- and post-test averages (tests within subjects) of the shot put technique ($p<0.05$) tests values were statistically different according to measurement in time (interaction; $p<0.05$). Similar results were observed in the tests between subjects ($p<0.05$). When analyzing the differences between the groups, it was observed that the shot put technique (Δ%: 50.88) test of the experimental group (plyo-training) had higher development percentages compared to the shot put technique (%Δ: 1.69) tests of the control group ($p=.00$).

According to the results of Table 3, it was observed that pre- and post-test averages (tests within subjects) of the countermovement jump ($p<0.05$), standing broad jump ($p<0.05$), triple standing jump ($p<0.05$) and standing medicine ball throw ($p<0.05$) test values were statistically different according to measurement over time

Table 1. Exercises included on the plyometric training program

Exercises		
Lower body exercises	Upper body exercises	Trunk exercises
Jump in place	Throws (power drop)	Medicine ball throw
Standing jumps	Plyometric push-ups	45^0 sit-up
Multi hops and jumps (lateral barrier hop)	Plyometric push-ups Bench Press with Medicine Ball	V – sit ups (one rapid repetition)
Bounds (leaping movement upward)	Depth Push-Ups (from Box)	Frog sit ups (one rapid repetition)
Bounds (power skip)	Alternating Med Ball Plyometric Push Up	Sit-up with medicine ball
Box drills	Push-ups (gymnasti parallels)	Med ball thow (sitt position)
Depth jumps	Theraband internal rotation (start position).	
Single-leg vertical jump	Theraband internal rotation (finish position).	
	Theraband external rotation (finish position).	

Note: Depth jumps exercises were not applied between first to sixth week and in the last week.

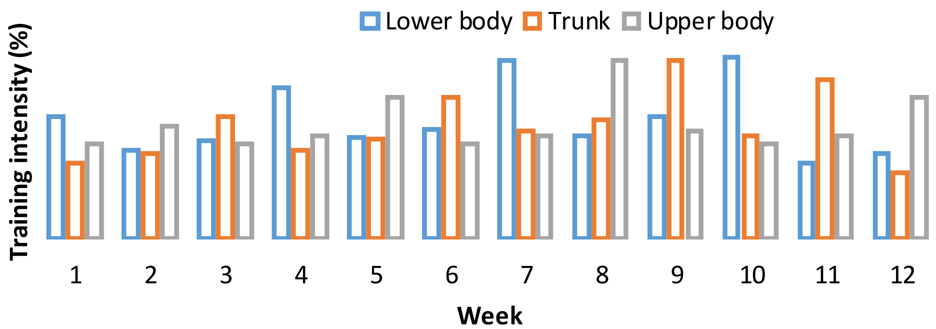

Figure 2. Weekly training intensity

(interaction: CMJ, SBJ, TSJ, SMBTH; p<0.05). Similar results were observed in the tests between subjects (CMJ, SBJ, SMBTH; p<0.05, TSJ; p>0.05). When analyzing the differences between the groups it was observed that the countermovement jump (Δ%: 28.90), standing broad jump (Δ%: 26.19), triple standing jump (Δ%: 11.46) and standing medicine ball throw (Δ%: 16.07) results of the experimental group (plyo-training) had higher development percentages compared to the countermovement jump (%Δ: 0.00), standing broad jump (%Δ: 3.02), triple standing jump (%Δ: 1.22) and standing medicine ball throw (%Δ: 1.38) results of the control group (CMJ: p=.00, SBJ: p=.00, TSJ: p=.06, SMBTH: p=.00).

According to the results of Table 4, it was observed that pre- and post-test averages (tests within subjects) of the 10 meters run (p<0.05) and 20 meters run (p<0.05) values were statistically different according to measurement over time (interaction: 10mRUN; p<0.05, 20mRUN; p<0.05). The results observed in the tests between subjects were not statistically different (p>0.05). When analyzing the differences between the groups, it was observed that the 10 meters run test (Δ%: -12.67) and 20 meters run test (Δ%: -10.90) of the experimental group (plyo-training) had higher development percentages compared to the 10 meters run (Δ%: -3.05) and 20 meters run (Δ%: -2.31) tests of the control group (10mRUN: p=.01, 20mRUN: p=.14).

According to the results of Table 5 it is seen that pre- and post-test averages (tests within subjects) of the

Table 2. Impact of plyometric training in the shot put technique performance level

V	Groups	N	Pre-test	Post-test	Total	»		%Δ	η2
			X̄±SD	X̄±SD	X̄±SD	F	p		
SHP	Plio-training	110	5.7±1.14	8.6±1.33	7.2±1.5	55.19	.00*	50.88	
	Control Group	110	5.9±1.26	6.0±1.22	5.95±0.05			1.69	
	Total	220	5.8±1.20	7.3±1.81	6.55±0.75	› F =1032.139; p =.00*			
					‹ F =844.261; p =.00*				

NOTE: V – variable; *p<0.05. SHP: Shot put technique. X̄±SD: Mean and standard deviation. »: Tests of between-subjects' effects. ›: Testing effects within subjects (Greenhouse-Geisser). ‹: Interaction (Time*Groups). Δ%: development %. η2: partial eta squared, V: Variables

Table 3. Impact of plyometric training with respect to power ability (explosive force) factors

V	Groups	N	Pre-test	Post-test	Total	»		%Δ	η2
			X̄±SD	X̄±SD	X̄±SD	F	p		
CMJ	Plio-training	110	27.79±4.82	35.82±4.28	31.80±4.02	27.770	.00*	28.90	.11
	Control Group	110	28.44±5.27	28.44±4.90	28.44±0.00			0.00	
	Total	220	28.12±5.05	32.13±5.89	30.12±2.01	› F= 966.720; p=.00*			
					‹ F =1771.218; p=.00*				
SBJ	Plio-training	110	157.7±22.16	199.0±20.21	178.3±20.65	21.510	.00*	26.19	.09
	Control Group	110	162.0±23.43	166.9±24.65	164.4±02.45			3.02	
	Total	220	159.9±22.85	182.9±27.63	171.4±11.50	› F= 1343.167; p=.00*			
					‹ F =833.813; p=.00*				
TSJ	Plio-training	110	530.6±55.45	591.4±57.47	561.0±30.40	3.384	.06	11.46	.01
	Control Group	110	543.1±61.22	549.7±63.68	546.4±03.30			1.22	
	Total	220	536.9±58.61	570.5±64.02	553.7±16.80	› F= 650.362; p=.00*			
						‹ F =422.013; p=.00*			
SMBTH	Plio-training	110	453.1±61.80	525.9±61.44	489.5±36.40	11.073	.00*	16.07	.04
	Control Group	110	457.6±69.42	463.9±68.85	460.7±03.15			1.38	
	Total	220	455.3±65.61	494.8±72.20	475.1±19.75	› F= 556.802; p=.00*			
					‹ F =400.012; p=.00*				

NOTE: V – variable; *p<0.05. CMJ: Countermovement jump, SBJ: Standing broad jump, TSJ: Tipple standing jump, SMBTH: Standing medicine ball throw. X̄±SD: Mean and standard deviation. »: Tests of between-subjects' effects. ›: Tests of within subjects' effects (Greenhouse-Geisser). ‹: Interaction (Time*Groups). Δ%: development %. η2: partial eta squared.

plate tapping (p<0.05), foot-tapping against the wall (p<0.05), sit ups in 30 sec (p<0.05) and push-ups in 30 sec (p<0.05) test values were statistically different according to measurement over time (interaction: PLT, FTAW, SUP30s, SMBTH; p<0.05). Similar results were observed in the SUP30s (p<0.05) and PU30s (p<0.05) between subjects. However, the results showed that in the PLT and FTAW results between subjects did not have any statistical difference (p>0.05). When analyzing the differences between the groups, it was observed that the plate tapping (Δ%: -12.43), foot-tapping against the wall (Δ%: -9.32), sit ups in 30 sec (Δ%: 40.00) and push-ups in 30 sec (Δ%: 45.83) test of the experimental group (plyo-training) had higher development percentages compared to the plate tapping (Δ%: -2.18), foot-tapping against the wall (Δ%: -2.25), sit ups in 30 sec (Δ%: 2.01) and push-ups in 30 sec (Δ% :2.87) tests of the control group (PLT: p=.23, FTAW: p=.45, SUP30s: p=.00, PU30s: p=.00).

According to the results of Table 6, it was observed that pre- and post-test averages values (tests within subjects) of the dips (p<0.05) and flamingo balance (p<0.05) were statistically different according to measurement over time (interaction: D, FB: p=.00). Similar results were observed in the D test between subjects (p<0.05). However, the results indicated that there was no statistical difference (p>0.05) in the FB test between the subjects.

When analyzing the differences between the groups, it was observed that the dips (Δ%: 70.51) and flamingo balance (Δ%: -50.00) test of the experimental group (plyo-training) had higher development percentages compared to the dips (Δ%: 5.95) and flamingo balance (Δ%: -15.38) tests of the control group (D: p=.01, FB: p=.45).

Table 4. Impact of plyometric training in acceleration ability factors

V	Groups	N	Pre-test X̄±SD	Post-test X̄±SD	Total X̄±SD	» F	p	%Δ	η2
10mRUN	Plio-training	110	2.408±.35	2.103±.23	2.256±0.15	6.481	.01*	-12.67	.02
	Control Group	110	2.390±.33	2.317±.30	2.354±0.04			-3.05	
	Total	220	2.399±.34	2.210±.29	2.305±0.09	› F= 140.031; p=.00*			
					‹ F =52.581; p=.00*				
20mRUN	Plio-training	110	3.974±.53	3.541±.35	3.758±0.22	2.136	.14	-10.90	.01
	Control Group	110	3.888±.48	3.798±.45	3.843±0.04			-2.31	
	Total	220	3.931±.50	3.670±.42	3.800±0.13	› F= 161.382; p=.00*			
					‹ F =69.509; p=.00*				

NOTE: V – variable; *p<0.05. 10mRUN: 10 Meters run, 20mRUN: 20 Meters run. X̄±SD: Mean and standard deviation. »: Tests of between-subjects' effects. ›: Tests of within subjects' effects (Greenhouse-Geisser). ‹: Interaction (Time*Groups). Δ%: development %. η2: partial eta squared

Table 5. Impact of plyometric training in the speed of the upper and lower extremities and endurance in force factors

V	Groups	N	Pre-test X̄±SD	Post-test X̄±SD	Total X̄±SD	» F	p	%Δ	η2
PLT	Plio-training	110	10.86±1.66	09.51±1.32	10.18±0.68	1.404	.23	-12.43	.00
	Control Group	110	10.55±1.65	10.32±1.63	10.43±0.12			-2.18	
	Total	220	10.71±.166	09.82±1.53	10.31±0.45	› F= 252.953; p=.00*			
					‹ F =126.764; p=.00*				
FTAW	Plio-training	110	14.05±2.18	12.74±2.11	13.39±0.66	.572	.45	-9.32	.00
	Control Group	110	13.77±2.31	13.46±2.17	13.61±0.15			-2.25	
	Total	220	13.91±2.25	13.10±2.16	13.50±0.41	› F= 110.088; p=.00*			
						‹ F =41.907; p=.00*			
SUP30s	Plio-training	110	19.0±3.78	26.6±3.85	22.8±3.80	26.932	.00*	40.00	.11
	Control Group	110	19.9±4.24	20.3±4.17	20.1±0.20			2.01	
	Total	220	19.5±4.03	23.4±5.09	21.4±1.95	› F= 744.410; p=.00*			
					‹ F =619.485; p=.00*				
PU30s	Plio-training	110	16.8±7.38	24.5±7.36	20.6±3.85	8.783	.00*	45.83	.03
	Control Group	110	17.4±7.97	17.9±8.02	17.6±0.25			2.87	
	Total	220	17.1±7.67	21.3±8.36	19.1±2.10	› F= 510.631; p=.00*			
					‹ F =387.229; p=.00*				

NOTE: V – variable; *p<0.05. PLT: Plate tapping, (FTAW): Foot-tapping against the wall, SUP30s: Sit-ups in 30 secs, PU30s: Push-ups in 30 sec. X̄±SD: Mean and standard deviation. »: Tests of between-subjects' effects. ›: Tests of within subjects' effects (Greenhouse-Geisser). ‹: Interaction (Time*Groups). Δ%: development %. η2: partial eta squared.

Table 6. Impact of plyometric training of the speed of the upper and lower extremities and endurance in force factors

V	Groups	N	Pre-test X̄±SD	Post-test X̄±SD	Total X̄±SD	» F	p	%Δ	η2
D	Plio-training	110	7.8±5.16	13.3±5.69	10.6±2.8	6.60	.01	70.51	
	Control Group	110	8.4±5.79	8.9±5.52	8.65±0.25			5.95	
	Total	220	8.1±5.47	11.1±6.00	9.6±1.5	› F =489.327; p =.00*			
					‹ F =322.731; p =.00*				
FB	Plio-training	110	8.8±6.96	4.4±4.44	6.6±2.2	.57	.45	-50.00	
	Control Group	110	7.8±6.98	6.6±5.97	7.2±0.6			-15.38	
	Total	220	8.3±6.97	5.5±5.37	6.9±1.4	› F =84.899; p =.00*			
					‹ F =28.660; p =.00*				

NOTE: V – variable; *p<0.05. PLT: D: Dips, FB: Flamingo balance test. X̄±SD: Mean and standard deviation. »: Tests of between-subjects' effects. ›: Tests of within subjects' effects (Greenhouse-Geisser). ‹: Interaction (Time*Groups). Δ%: development %. η2: partial eta squared.

Discussion

In the study it was observed that pre- and post-test averages (within and between subjects) of the shot put technique (p<0.05) were statistically different according to measurement over time (interaction; p<0.05). When analyzing the development percentage, it was observed that the performance of shot put technique (Δ%: 50.8) of the experimental group compared to the shot put technique (Δ%: 1.6) results of the control group had developed by 49.2%.

If we refer to the research of Mustapha et al. [17], they also found significant statistical differences in the pre-test and post-test in the experimental sample for muscular strength and digital achievement in the shot put technique. According to the researchers, this result was due to the proposed training program based on scientific foundations of the application of physical exercises of quality that are related to the game, especially the use of the plyometric exercises (08 weeks & 02 times in one week). Furthermore, T-test values for the experimental sample was also (2.57 and 3.04) larger than the tabulated T-test, which means there was also the existence of a significant difference between the pre-test and post-test calculated average in favor of the post-test group [17].

Similar results in the shot put technique were also observed in analyzing the impact of the plyometric training program in the motor abilities related to the shot put technique. Applied plyometric training program benefits were not just in the shot put technique, but also improved all motor abilities related to the technique such a power, strength endurance, speed, and acceleration. Thus, the development of the shot put technique occurred by the increase in motor abilities related to the shot put technique as a result of the plyometric training program.

Referring to the literature, ten weeks of strength and power training induced significant increases in the shot put throw, standing long jump work production, and sprinting performance. These changes were accompanied by adaptations in muscle thickness and fascicle length. The current data suggest that examination of muscle thickness and performance in explosive field tests may partly predict the training-induced increase in actual track and field throwing performance [18].

When the same analyses were applied in the explosive force factors, it was observed that the differences within subjects and between subjects of the countermovement jump (p<0.05), standing broad jump (p<0.05), triple standing jump (p<0.05) and standing medicine ball throw (p<0.05) test values were statistically different (p<0.05). When analyzing the development percentage, it was observed that the countermovement jump (Δ%: 28.9), standing broad jump (Δ%: 26.1), triple standing jump (Δ%: 11.4) and standing medicine ball throw (Δ%: 16.0) test results of the experimental group (plyo-training); compared to the countermovement jump (Δ%: 0.00), standing broad jump (Δ%: 3.0), triple standing jump (Δ%: 1.2) and standing medicine ball throw (Δ%:1.3), have shown higher development percentages (CMJ: 28.9%, SBJ: 23.1%, TSJ: 10.2%, SMBTH: 14.7%).

Based on the literature, we can see that there were statistically significant differences in post-test between the control and experimental sample in favor of the experimental group. This indicates that plyometric exercises were more effective in improving performance in the shot put through the use of medicine balls and iron balls with different weights. This actually confirms the effectiveness of using plyometric exercises leads to an improvement in physical abilities and performance in sports activities [19, 20]. If we see the literature, we can verify that a combined plyometric and squat training program significantly increased vertical jump results compared to training with squats or plyometric alone [21].

With regards to acceleration abilities, it was observed that within subjects the 10 meters run (p<0.05) and 20 meters run (p<0.05) test values were statistically different according to measurement over time. The results observed in the tests between subjects were not statistically different (p>0.05).

When analyzing the development percentage, it was observed that the 10 meters run test (Δ%: -12.6) and 20 meters run (Δ%: -10.9) test of the experimental group (plyo-training) have shown higher development percentages compared to the 10 meters run (Δ%: -3.0) and 20 meters run (Δ%: -2.3) tests of the control group (10m run: 9%, 20m run: 8.6%).

The literature showed that after a plyometric training program of 10 weeks duration found that the jump program increased the velocity for running distances of 0-30, 10-20, and 20-30 [22]. Results of several investigations involving adults suggest that combining plyometric training with other training programs may be useful for enhancing muscular performance and running velocity [21, 23, 24].

Analysis of speed, strength endurance and balance, showed that within subjects and between subjects of the plate tapping ($p<0.05$), foot-tapping against the wall ($p<0.05$), sit ups in 30 sec ($p<0.05$) and push-ups in 30 sec ($p<0.05$) tests, were impacted by plyometric training applied on the study sample ($p<0.05$).

When analyzing the development percentages, it was observed that plate tapping (Δ%: -12.4), foot-tapping against the wall (Δ%: -9.3), sit ups in 30 sec (Δ%: 40.0) and push-ups in 30 sec (Δ%: 45.8) tests of the experimental group (plyo-training) showed higher development percentages compared to the plate tapping (Δ%: -2.1), foot-tapping against the wall (Δ%: -2.2), sit ups in 30 secs (Δ%: 2.0) and push-ups in 30 sec (Δ%:2.8) tests of the control group (PLT: 10.3%, FTAW: 7.1%, SUP30s: 38.0%, PU30s: 43.0%).

Kontou et al. (2018) in their study confirms that after isometric push-ups, participants have a higher percentage increase in shot-put performance [25]. Moreover, within subjects and between subjects regarding the dips and flamingo balance tests, values were statistically different ($p<0.05$). When analyzing the development percentage, it was observed that the dips (Δ%: 70.5) and flamingo balance (Δ%: -50.0) test of the experimental group (plyo-training) had higher development percentages compared to the dips (Δ%: 5.9) and flamingo balance (Δ%: -15.3) tests of the control group (D: 64.6%, FB: 34.7%).

The research showed that when the effects of psychomotor training on balance was taken into consideration, a statistically significant difference was found between pre-test ($\bar{x}$ 4.59) and post-test ($\bar{x}$ 1.98) in the training group (experimental group) ($p<0.01$). No statistically significant difference was found between the balance pre-test ($\bar{x}$ 4.54) and post-test ($\bar{x}$ 3.69) in the non-training group (control group) ($p<0.05$) [26].

Conclusion

In conclusion, the impact of the plyometric training program on motor abilities related to the shot put technique also observed similar results as the training program's impact on the shot put technique. The applied plyometric training program benefits were not just in the shot put technique but also improved all motor abilities related to the shot put technique such as power, strength endurance, speed and acceleration. Therefore, the development of the shot put technique occurred by an increase in motor abilities related to the shot put technique as a result of the plyometric training program.

Conflict of interests

No potential conflict of interest was reported by the authors.

References

1. Halliwell B, Gutteridge JMC. *Free Radicals in Biology and Medicine*, Oxford University Press; 1999.
2. Driss T, Vandewalle H, Monod H. Maximal power and forcevelocity relationship during cycling and cranking exercises in volleyball players. *J Sports Med Phys Fitness,* 1998; (38): 286–293.
3. Durand S, Beaune B, Gagé G, Ripamonti M, Rahmani A. Puissance anaérobie des membres inférieurs chez des joueurs de tennis de deuxième et troisième série [Anaerobic Lower Limb Potency in Second and Third Round Tennis Players]. *Sci Sports,* 2009; (24):320–322. (In French). https://doi.org/10.1016/j.scispo.2008.12.002
4. Judge LW. *The Complete Track and Field Coaches' Guide to Conditioning for the Throwing Events*. Monterey, CA: Coaches Choice Publishing; 2008.
5. Judge LW, Burke JM, Moreau C. Neural adaptations with sports specific resistance with highly skilled athletes. *J Sport Sci,* 2003; (21): 419–427. https://doi.org/10.1080/0264041031000071173
6. Young M. *Preparing for the specific neuromuscular and biomechanical demands of the javelin throw.* National Throws Coaches Association; 2007.
7. Stone MH, Sanborn K, O'Bryant HS, Hartman M, Stone ME, Proulx C, et al. Maximum strength-power performance relationships in collegiate throwers. *J Strength Cond Res,* 2003; (17): 739–745. https://doi.org/10.1519/00124278-200311000-00019
8. Terzis G, Georgiadis G, Vassiliadou E, Manta P. Relationship between shot put performance and triceps brachii fiber type composition and power production. *Eur J Appl Physiol*, 2003;90:10–5. https://doi.org/10.1007/s00421-003-0847-x
9. Chaouachi A, Brughelli M, Levin G, Boudhina NB, Cronin J, Chamari K. Anthropometric physiological and performance characteristics of elite team-handball players. *J Sports Sci,* 2009;(15):151–7. https://doi.org/10.1080/02640410802448731
10. Nešić G, Ilić D, Majstorovic N, Grbic V, Osmankac N. Effects of training on basic and specific motor abilities of volleyball players aged 13-14 years. *SportLogia,* 2013; 9(2): 119–27. https://doi.org/10.5550/sgia.130902.en.007N
11. Bjelica D, Fratrić F. *Sport training - theory, metodics and diagnostics*. Faculty of sport and physical education; 2011.
12. Badrić M. *The correlation between kinesiological activities in free time and motor skills of high school students*. 2011. (In Croatian).
13. Günay M, Tamer K, Cicioğlu İ, Şıktar E. *Spor Fiziyolojisi ve Performans Ölçüm Testleri* [Sports Physiology and Performance Measurement Tests]. Ankara: Gazi Kitabevi Tic. Ltd. Şti; 2017. (In Turkish).
14. Baumgartner TA, Oh S, Chung H, Hales D. Objectivity, Reliability, and Validity for a Revised Push-Up Test Protocol. *Measurement in Physical Education and Exercise Science,* 2002; 6(4): 225–42. https://doi.org/10.1207/S15327841MPEE0604_2
15. Hashim A. Objectivity, Reliability and Validity of the 90º Push-Ups Test Protocol Among Male and Female Students of Sports Science Program. *Journal of Physical Education and Sport,* 2012; 12(1): 103–6.

16. Coyne J. *Influence of anthropometric and upper body strength qualities on surfboard paddling kinematics*. [Thesis]. Edith Cowan University; 2015.
17. Mustapha B, Houcine B, Touati A, Djamel M. Effectiveness of plyometric exercises to improve muscular strength and digital achievement for students in shot put. *International Journal of Physical Education, Fitness and Sports,* 2019; (2): 36–41. https://doi.org/10.26524/ijpefs1925
18. Zaras N, Stasinaki A, Methenitis S, Terzis G. Track and field throwing performance prediction: Training intervention, muscle architecture adaptations and field tests explosiveness ability. *Journal of Physical Education and Sport,* 2019; (2): 436 –443.
19. Mehdi Kadhim Ali. Effect of the plyometric training and weight training to develop the explosive strength and rapid force to improve the performance in shot put, *Journal of Physical Education and Sports Science,* 2002; (2): 7–22.
20. Bensikaddour H, Benzidane H, Touati AB, Mokrani D. The effect of using plyometric exercises to improve some physical abilities and performance in the triple jump (hop, step, jump). *The Swedish Journal of Scientific Research*, 2015; (2): 53–61.
21. Adams K, O'Shea P, O'Shea KL, Climstein M. The effect of six weeks of squat, plyometric andsquat-plyometric training on power production. *Journal of Applied Sport Science Research,* 1992; 6(1): 36–41. https://doi.org/10.1519/00124278-199202000-00006
22. Kotzamanidis C. Effect of plyometric training on running performance and vertical jumping in prepubertal boys. *J Strength Cond Res*, 2006; (2): 441–445. https://doi.org/10.1519/00124278-200605000-00034
23. Fatouros I, Jamurtas Z, Leontsini D, Taxildaris K,Aggelousis N, Kostopoulos N, et al. Evaluation of plyometric exercises training, weight training and their combination on vertical jump performance and leg strength. *The Journal of Strength and Conditioning Research,* 2000; (14): 470–476. https://doi.org/10.1519/00124278-200011000-00016
24. Miller GM, Herniman JJ, Ricard DM, Cheatham CC, Michael JT. The effects of a 6-week plyometric training program on agility. *Journal of Sports Science and Medicine,* 2006; (5): 459–465.
25. Kontou EI, Berberidou FT, Pilianidis TC, Mantzouranis NI, Methenitis SK. Acute Effect of Upper and Lower Body Postactivation Exercises on Shot Put Performance. *Journal of Strength and Conditioning Research*, 2018; (4): 970–982. https://doi.org/10.1519/JSC.0000000000001982
26. Yazar Soyadı YA, Yaman N, Berisha M, Hergüner G, Yaman Ç, Önal A. Examining the effect of psychomotor training on the coordination, agility and balance in 10-11 year-old girls. *International Refereed Academic Journal of Sports*, 2016:137–137. https://doi.org/10.17363/SSTB.20162124346

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ORIGINAL ARTICLE

Functional state dynamics in cross-country skiers in the summer and autumn preparatory phase

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim To study changes in the functional state of professional Russian cross country skiers in the course of the preparatory phase and their effects on their competition ratings.

Material: In this study we examined 10 cross-country skiers. The functional state was assessed through a maximal load bicycle ergometer test, coordination and special performance tests. Concentrations of lactate and cortisol were checked in the blood plasma of participants.

Results: The training effects on general physical preparedness and special physical preparation in September in comparison with June were observed as an increased number of pull-ups on a pull-up bar (by 14%) and decreased time of the roller ski test (by 4%). In autumn higher systolic (by 11%) and diastolic (by 10%) arterial blood pressure levels, higher levels of plasma lactate and cortisol (by 48% and 64%, respectively) were detected ($p<0.05$). At anaerobic threshold the following increased: total performance capacity (by 13%), oxygen consumption (by 14%), watt pulse (by 5%), respiratory minute volume, oxygen utilization coefficient, and oxygen pulse (by 15%) ($p<0.05$-0.01) at rest before the ergometer test. In September upon completion of the ergometer test we observed an increase of oxygen pulse (by 7%), watt pulse (by 10%), and oxygen utilization coefficient (by 24%) ($p<0.05$). In autumn at the 5th minute of recovery after the ergometer test the heart rate recovered 11% faster, blood lactate – 29% faster, and the oxygen utilization rate increased by 15% ($p<0.05$-0.01). In June no statistically significant correlations were found between the studied indicators. In autumn statistically significant correlations appeared between indicators of the cardiorespiratory system, physical performance, and coordination test time.

Conclusions: The package program for the summer-autumn training period contributes to the improvement of the functional status of the cross-country skiers and to the development of physical power, endurance, increased strength of the upper limbs, increased speed of movement on roller skis, faster and more complete recovery of physiological and biochemical parameters.

Keywords: physical performance, cross-country skiers, anaerobic threshold, preparatory phase, coordination movements.

Introduction

Cross-country skiing requires an athlete to develop endurance, which depends on aerobic performance. Sprint races and mass starts in competitions determine the ability to generate high level of muscle effort [1]. Assessment of functional state of organs and systems, which can change as a result of training exercises (TE), can be used by both scientists and coaches to obtain objective information on effects of the training process (TP) [2, 3]. According to the literature [1, 4], combined TE aimed at developing endurance and strength in the preparatory period (PP) contribute to lowering the intensity of the cardio-respiratory system (CRS), reducing blood lactate during exercise, and increasing maximum oxygen consumption (VO_2), which is reflected in improving sports results in the competition period. These were accompanied by higher performance and better results during competition period. It is known [4] that these indicators are partially determined by the activity of the neuromuscular apparatus, the development of which is facilitated by strength training. However, combined TE are still being discussed among researchers, trainers and athletes [5]. Specialized literature does not give a decisive answer about the effects of combined TE during 16 microcycles of PP on the endurance development in cross-country skiers. Older studies [6-8] insist on the lack of positive effects on endurance, and more current ones [9] contradict those results. This might have been caused by different strategies in strength training of athletes in cyclic sports.

Significance. Modern studies [1, 4] are focused on describing of various training programs used in the preparatory phase (PP). Current studies [1, 4] are focused on describing of various training programs used in the preparatory phase (PP). However the available literature lacks reports on changes in general physical performance, special physical preparedness, physiological parameters in elite ski runners during 16 micro-cycles of TP in summer and autumn, when using combined TE.

The aim of the study was to assess the functional state of elite cross-country skiers during the TP in the summer and autumn PP and to draw connections with their competition ratings.

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Materials and Methods

Participants. This study was conducted in the Department of Ecological and Medical Physiology of the Institute of Physiology of the Komi Science Centre of the Ural Branch of the Russian Academy of Sciences (IPhys FCR Komi SC UB RAS) (Syktyvkar, Russian Federation) at the beginning (June) and the end (September) of the PP in 2018 in the morning and afternoon. Ten male professional ski runners, all masters of sports according to the Russian classification, participated in the study, two of them were in the Russian Federation ski team, and eight – in the Komi Republic team, age 22.5±3.3 yr, height 178.5±5.6 cm, RUS point – (RUS Race score is a universal assessment of the result shown by an athlete in a race of the CCSFR (Cross-country skiing Federation of Russia) calendar, compared to the race winner result) 149.0±70.0 pp. The athlete track record of all participants was 12-14 years. All participants signed informed consent for participating in the study. The protocol of the study was approved by the Committee on Bioethics of the Institute of Physiology of Komi SC UB RAS, and conformed to the Declaration of Helsinki.

Research design. Examination procedure. The height and body mass of participants were registered using height meter combined with medical scales (Russia), percentage of fat in body mass was measured with bioelectrical impedance meter Omron BF 302 (Omron, Japan). Vital capacity was determined using computerized spirograph SPM-01 R-D (Russia), systolic (SAP) and diastolic (DAP) arterial pressure was assessed by auscultating for Korotkoff sounds with the Microlife Model BP AG1-30 tonometer (Switzerland). The functional state of our participants was assessed by conducting a maximal bicycle ergometer test for determination of VO_2max; the test was performed with ergospirometric system Oxycon Pro (Erich Jaeger, Germany). The protocol of the ergometer test [10, 11], is presented in fig. 1.

During the test several parameters - respiratory minute volume, breath rate, oxygen consumption, maximal oxygen consumption, heart rate – were registered in the "breath-by-breath" mode with averaging at 15-second intervals. At each stage of the test SBP and DBP were measured. The data were used for computation of respiratory volume, oxygen pulse, oxygen consumption percentage of maximal oxygen consumption at anaerobic threshold (AT), watt pulse, oxygen utilization coefficient. The performance capacity was registered at anaerobic threshold (AT). Capillary blood samples were obtained from each participant at rest, immediately after cessation of pedaling, and at the 5th minute of recovery. Levels of lactate (commercial kit, Sentinel, Italy) and cortisol (commercial kit, Alcor Bio, Russia) were assayed by enzyme-linked immunoassay with ChemWell 2900 analyzer (USA). The effects of PP and bicycle ergometer testing on motor coordination were evaluated by a test on a coordinimeter. Coordinimeter tests were conducted in the sitting position before and after bicycle ergometer testing lasting to muscular failure. Coordinimeter is a device with mobile upper and lower platforms joined by adjustable shaft for changing the height of the device. It is controlled by both arms and legs of a person under test. This allows measuring the time required for completion of the test for arms-and-legs coordination when they work as a single kinematic chain of movement [12].

Characteristics of TP. The main purpose of the 16 microcycles of PP was to develop both functional capabilities of the cardiorespiratory system and physical performance – endurance and strength. This aim was achieved by means of scheduled physical exercises. All participants followed the same training plan and had the same standardized diet that provided 6000 kkal/day. The data on TE (in km and hours) and exercise intensity was obtained from personal heart rate monitors (Polar, Kempele, Finland).

The HR zones were computed from maximal HR data [10]. Recommendations for developing general physical preparedness and special performance were based on the five HR zone model, although it was suggested that during TE planning and implementation the participants didn't push themselves than the fourth zone. During PP a gradual increase of aerobic performance was achieved by stepwise building-up of the cyclic load in each HR zone (Fig. 1) while training general and specialized capacities.

In addition to increasing physical and special performance for the development of strength endurance in the summer stage (June - August), TE were used (Table 1), including 44.4% of strength exercises (circular method), in the fall (September) - 58.3% (repeated method). Throughout the whole PP these TE were performed on the first and fourth days of the microcycle in the afternoon

						...AT...					
W, Wt			0	120	160	200	...	400			
$\vec{\vartheta}$ rpm			60								
Time, min	2	3	1	3	5	7	...	17	1	3	5
Step examination procedure	position prone siting		load						recovery		
♥ - assessed SAD/DAD	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥	♥

Figure 1. The protocol of the ergometer test

Table 1. Additional training protocol for cross-country skiing training

June – August		September	
Exercises	**Volume**	**Exercises**	**Volume**
1. Wide grip pull-up 2. Bench dips on a 30 cm bench 3. Incline sit ups 4. Step ups on 50 cm platform 5. Squat jumps. 4. Step ups on 50 cm platform 6. Back extensions (hyperextensions) 4. Step ups on 50 cm platform 5. Squat jumps 6. Back extensions (hyperextensions) 7. Parallel bar dips 8. Box jumps (50 cm) 9. Hanging leg raise 10. Narrow push-up	Two rounds, ten repetitions each.	1. Wide grip pull-up 2. Chest-focused dip 3. Bench press 4. Smith machine barbell squat 5. Barbell seal row 6. Walking lunges with dumbbells 7. Seated cable row	4x12 – 16 repetition; 2,5 min recovery; 4 rounds, 12-16 repetitions; 2,5 minutes of recovery; 40%-50% of maximal weight

and preceded the high-intensity exercise on the following day.

Physical performance tests. At the beginning and at the end of PP benchmark TE were performed. Their purpose was to assess the levels of general physical preparedness (GPP) and special physical preparation (SPP). For specialized performance testing our participants did a roller ski free skating test according to the following protocol: first lap (4 km) – without poling, second lap (4 km) – with poling and increased arm work, third lap (4 km) – free skating. On the following day a physical performance test (maximum repetitions in one attempt) was performed: 1. Wide grip pull-up; 2. Chest-focused dip (maximum arm bending); 3. Hanging leg raise to touch the bar with feet.

Data on competition results in the November-December 2018 competition period (RUS points, rating positions obtained in the website of the Cross Country Ski Federation of Russia) [13] were used to assess and effectiveness on competition performance.

Statistical analysis. The data obtained were analyzed with Statistica software (v.6.0, StatSoft, USA). Normal distribution check was performed with Shapiro-Wilks test. The data reliability was assessed by Wilcoxon's W-test. Interrelationships between physiological parameters during the ergometer test, control physical performance tests, motor coordination and competition performance were assessed by Spearman's correlation coefficient. The data are presented as median and interquartile range (25th and 75th percentiles), (Me) (25%; 75%). Test results were considered significant at p *<0,01 - 0,05.*

Results

The correlation between exercises at different heart rate zones and the total volume of cyclic load is presented in Fig. 2.

The results of our study are presented in table 2 and 3. Tests of GPP и SPP showed statistically significant increase of strength endurance in wide grip pull-up (by 14%, *p<0.05*) from 24.0 (21.0;24.0) to 28.0(22.0;29.5) rep and decreased time of the roller ski test (by 4 %, p<0.05) from 1980.0 (1914.0;2017.0) to 1897 (1897.0;1978.0) sec. Remarkably, the lap time in roller ski test was significantly shorter (by 39 sec) in the first lap (without poling), other parameters tended to increase.

The results of testing coordination abilities in June and September did not differ statistically significantly. We marked falling trends in time: before the test on a bicycle ergometer in September compared to June, it decreased by 27.0 sec, from 85.0 (71.5; 98.3) to 58.0 (53.5; 93, 7) sec, and after the test – by 13.0 sec, from 73.0 (56.7; 92.5) to 60.0 (51.2; 79.0) sec. To clarify the formation of a motor skill in the repeated testing on the coordinateometer, athletes were divided into two groups: those who performed the second test with shorter time and those who showed longer time. Thus, it was noted that 60% of the subjects improved the time of the second coordination test at the beginning of the PC, and 40% – at the end of the PC.

Dynamic of changes in physiological and biochemical parameters, body mass, percentage of fat in body mass, before and after the TP is shown in Table 2.

The analysis of biochemical parameters registered at rest before the test (Tab. 2) showed higher cortisol (p<0.01) and lactate levels in blood (p<0.05) in September in comparison with June. Also, SBP and DBP levels were significantly higher in September (p<0.05). Other physiological parameters showed differing trends and remained within corresponding reference ranges.

In September compared with June on AT we observed significantly higher oxygen consumption (p<0.01), respiratory minute volume (p<0.05), and power (p<0.05). Values of several calculated parameters – oxygen pulse, watt pulse, oxygen utilization coefficient on AT and upon completion of the bicycle ergometer test were also significantly increased in September (p<0.01-0.05).

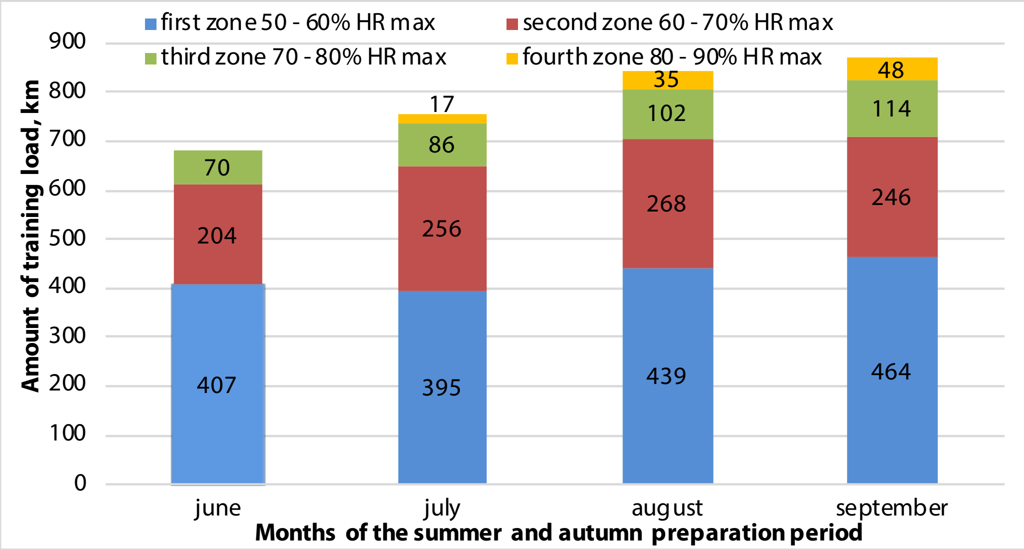

Figure 2. Relative amount of cyclic exercise in different HR zones in the total amount of cyclic exercises.

Also, in September at the 5th minute of recovery after the ergometer test we observed a significant increase of oxygen utilization coefficient ($p<0.05$), and a decrease of heart rate and blood lactate level ($p<0.05$). Other parameters displayed diverse trends and also remained in their respective reference ranges.

In autumn we observed significant negative correlations between physiological parameters during the bicycle ergometer test and control TE, coordinimeter test times, and competition performance of ski runners (Tab. 3).

The correlation analysis showed a significant strong negative correlation between oxygen consumption at AT and time of the roller ski test (Tab. 4) and also between watt-pulse and coordination test time after the bicycle ergometer test to muscle failure, a mean negative correlation between VO_2/ kg in AT and RUS scores in sprint, AT load power and time of the special roller ski test, as well as between VO_2 at the end of the test "to failure", load power and time of the second coordination test.

Discussion

Our results suggest that additional strength and speed training program was beneficial and increased strength endurance in athletes who participated in our study. Higher number of pull-up repetitions reflected increased strength and endurance of *latissimus dorsi* muscles, arm and forearm flexors, that are involved in poling [14]. We estimated the observed decrease of 12 km roller ski test time as a marker of increased specialized endurance in our participants [15]. Similar changes were noted in Norwegian skiers on the roller ski test after the 12-week PP [4]. In our opinion significantly better performance parameters in September were, a result of a successful training program.

Increased blood pressure values (both SBP and DBP) at rest before ergometer test in September were caused by both intensive physical training in previous months and by seasonal dynamics of circulatory system in its year cycle [16]. Increase in training intensity affected balances in vegetative nervous system, and caused changes in neuroendocrine function of adrenal cortex. In September we observed statistically significant (*$p< 0.01$*) increased blood cortisol levels. Being glucocorticoid hormone and therefore involved in developing endurance, cortisol is capable of causing hypertension if it is overproduced [16]. Trends towards increased blood pressure at rest before the ergometer test were observed previously in soldiers in September (in comparison with June; on average 118.9 (8.4) mmHg by 74.3 (4.2) mmHg and 114.7 (7.9) mmHg by 69.2 (6.1) mmHg, respectively) [15]. We assume that in our study in athletes seasonal increases of SBP and DBP contributed along with other factors affecting BP – decreased air temperature [17] and increased blood cortisol levels – to the observed blood pressure increase. It is important to stress that despite being increased in September in comparison with June SBP and DBP parameters in our participants remained in normotonic reference range in both months.

Increased lactate levels at rest before the bicycle ergometer test observed in our study were possibly caused by both training regimen and by seasonal variation of that metabolite [17]. Our earlier observations showed that in the year cycle cross country skiers at rest demonstrate increased lactate levels in September in comparison with June [2.3 (1.9; 2.3) mmol/l against 1.8 (1.5; 2.2) mmol/l, respectively; $p<0.001$; unpublished data]. Those changes were probably caused by increased physical activity (the beginning of the active training period) and, by increased amino acid utilization [17]. Amino acids are metabolized into tricarboxylic acid cycle and further oxidized through their transformation into pyruvate with increased glycolysis contributors to increased lactate levels at that time of the year.

Power is one of the parameters reflecting optimal functioning of the key physiological systems in performing specific physical tasks [1]. It is known that in cross country

Table 2. Physiological and biochemical parameters of ski runners at the beginning and at the end of the training period

Indicators	**June**	**September**
Body mass, kg	73.4(72.1;74.9)	72.6(70.8;75.9)
Percentage of fat in body mass, %	12.2(9.6;12.6)	10.2(9.0;10.7)
Maximal power, Wt		
In anaerobic threshold	280.0(280.0;280.0)	320.0(280.0;320.0) *
Upon completion of the ergometer test	360.0(330.0;400.0)	360.0(330.0;400.0)
Systolic blood pressure, mmHg		
At rest, in seating position	110.0(103.0;113.0)	123.0(112.0;131.0) *
At anaerobic threshold	198.0(177.5;199.0)	195.0(186.5;207.5)
Upon completion of the ergometer test	202.0(180.0;209.0)	205.0(193.0;218.0)
Recovery, 5th minute	127.0(122.0;131.5)	122.0(113.5;136.5)
Diastolic blood pressure, mmHg		
At rest, in sitting position	72.0 (70.0;78.5)	80.0(78.0;88.0)*
At anaerobic threshold	70.0(55.0;86.0)	75.0(67.0;87.0)
Upon completion of the ergometer test	70.0(60.0;90.0)	68.0(60.0;79.5)
Recovery, 5th minute	68.0(55.5;71.5)	70.0(70.0;78.0)
Heart rate, bpm		
At rest, in sitting position position	63.0(60.2;71.5)	61.5(55.0;66.8)
At anaerobic threshold	158.0(151.5;162.3)	150.0(148.0;167.0)
Upon completion of the ergometer test	184.0(175.0;186.0)	172.0(156.3;180.8)
Recovery, 5thminute	101.5(97.3;106.0)	90.0(80.3104.5) *
Oxygen consumption, l/min		
At rest, in sitting position position	0.346(0.281;0.392)	0.300(0.280;0.342)
At anaerobic threshold	3.381(3.214;3.437)	3.926(3.505;4.259) **
VO_2 max	4.539(4.086;4.651)	4.462(4.231;4.790)
Upon completion of the ergometer test	4.347(4.046;4.433)	4.380(3.953;4.670)
Recovery, 5th minute	0.762(0.689;0.908)	0.754(0.683;0,820)
Breath rate, min^{-1}		
At rest, in seating position	13.0(11.2;14.8)	13.5(11.5;16.0)
In anaerobic threshold	33.0(29.5;35.3)	32.0(31.0;38.0)
Upon completion of the ergometer test	47.5(43.0;53.7)	39.5(37.0;52.7)
Recovery, 5thminute	25.0(22.5;26.7)	24.0(23.5;24.7)
Respiratory minute volume, l/min		
At rest, in seating position	10.5(9.3;11.8)	10.2(8.5;11.8)
In anaerobic threshold	90.0(86.3;98.3)	106.0(89.0;108.0)*
Upon completion of the ergometer test	148.5(141.7;165.5)	127.0(98.5;183.7)
Recovery, 5thminute	33.5(32.3;36.5)	27.0(26.0;33.4)
Oxygen pulse, ml/hr		
At rest, in seating position	5.5(4.4;6.0)	5.3(4.8;5.8)
In anaerobic threshold	21.6(21.2;22.0)	25.4(23.3;26.3)**
Upon completion of the ergometer test	23.5(23.0;24.2)	25.4(24.9;26.0)**
Recovery, 5thminute	7.7(6.8;8.6)	9.0(8.7;9.9)
Watt/pulse, w/beats		
In anaerobic threshold	1.8(1.7;1.8)	1.9(1.8;2.0)*
Upon completion of the ergometer test	1.9(1.8; 2.1)	2.1(2.0;2.1)*

Table 2 (Cont.)

Oxygen utilization coefficient, ml/min		
At rest, in seating position	32.7(30.0;35.0)	32.1(28.1;34.6)
In anaerobic threshold	21.6(21.2;22.0)	25.4(23.3;26.3)*
Upon completion of the ergometer test	27.0(25.1;30.0)	35.4(25.0;38.4)*
Recovery, 5th minute	22.4(21.3;24.8)	26.2(23.0;28.8)*
Cortisol, mmol/l		
At rest, in seating position	517.5(476.3;590.8)	801.5(693.0;964.3)**
Lactate, mmol/l		
At rest, in seating position	1.4(1.3;1.5)	2.7(1.9;3.0)*
In anaerobic threshold	4.9(4.3;5.7)	4.8(4.6;5.5)
Upon completion of the ergometer test	9.0(8.3;9.8)	6.7(6.1;8.0)
Recovery, 5th minute	9.0(8.2;10.2)	6.4(5.6;8.6)*

NB: data are presented as Me (25%; 75%). Differences between June and September were considered statistically significant at: *– p<0,05; ** – p<0,01

Table 3. Correlations between physical performance with special physical training and the competition results and results of the second coordination test

Indicators	*rS*	*p* **level**
VO_2/kg AT and time of roller ski test, sec	-0.881	0.001
Watt pulse upon completion of the ergometer test, Wt/hr and second coordinimeter test times, sec	-0.803	0.05
VO_2 AT/kg, ml/min/kg and RUS points in sprint	-0.785	0.05
Load in AT, Wt and time of roller ski test, sec	-0.729	0.01
Oxygen pulse upon completion of the ergometer test, ml/hr and second coordinimeter test times, sec	-0.693	0.05
Load upon completion of the ergometer test, Wt and second coordinimeter test times, sec, time of coordination test	-0.637	0.05

NB: rS – rate correlations Spearman's

skiers performing physical work at AT the observed increase in oxygen consumption is caused by increased oxygen uptake by muscles, and is not accompanied by excessive increase of lactate levels [16]. In our study in September we observed AT in our participants at higher load and oxygen consumption than in June, with constant lactate level. In our opinion that finding signifies an increase in functional reserves of the oxygen transport system and optimization of physiological processes. It is important to note that maximal oxygen consumption values remained the same, and that the increase of oxygen consumption at anaerobic threshold reflected relative change in the same range (from 77.4% (72.6%; 82.9%) of VO_{2max} in June to 87.6% (77.0%; 92.7%) of VO_{2max} in September). Therefore, we concluded that the higher the aerobic performance capacity in athletes, the less is the contribution of anaerobic glycolysis in the maximal ergometer test.

By the end of preparatory period cross country skiers in our study had higher oxygen consumption per kg of body mass (53.5 ml/min/kg) than ski runners (37.6 ml/min/kg) similar by anthropometric characteristics to our group did [18]. Increased minute respiratory volume at anaerobic threshold in ski runners, probably, was a consequence of increased physical load and power that increased oxygen consumption and respiratory volume. The so called "sport type of breathing", characterized by increased respiratory volume and decreased rate, is considered more economical [17]; we observed exactly such changes in September (p>0.05).

In maximal physical exercise the main performance criteria are considered to be parameters of effectiveness and economy: watt-pulse, oxygen pulse, oxygen utilization quotient [19]. In our study we observed an improvement in those parameters, both on AT and at the time of voluntary termination of the test.

Recovery is characterized by different involvement of various parameters of functional economy and effectiveness [19]. Higher oxygen utilization quotient reflects more effective oxygen utilization when accompanied with trends towards decrease in minute respiration volume and oxygen consumption. We believe that it is caused by changes in the gas exchange in lungs, decreased speed of blood flow through lung vessels that gives erythrocytes more time to expel CO_2 and absorb O_2 [20].

Physical exercises aimed at development of aerobic capacity and performance [21] supposedly caused the significant decrease of heart rate ($p<0.05$) in September in comparison with June, that, in our opinion, reflected more economical work of circulation in athletes.

Skeletal muscles are not the key producers of lactate in physical exercise, they are also tissues that utilize lactate [22]. Our opinion is that the observed decrease of plasma lactate at the 5th minute of recovery (in September in comparison with June) was a marker of adaptation to TE [23].

In June we observed no significant correlations between parameters that we monitored. In September, however, at AT we observed strong and significant negative correlations between oxygen consumption per kg of body mass and power, between time of roller ski test completion and competition rating in RUS points. It is known from previous studies of that subject that in athletes competing in cyclic sports that rely on endurance the parameters of performance at AT correlate significantly with competitions results [24].

Oxygen consumption at AT seem to correlate positively with speeds achieved when running ski [15]. It is known [12, 25], that the effectiveness of motional activity is a very specific feature characterizing coordination abilities and depends on the physiological indicators of the athlete, which is reflected in the ratio of the indicator of the effectiveness of physical work fulfillment watt-pulse –and time of fulfillment second coordination test. The correlation between exercise power, oxygen pulse, and the time of the coordination test after the test "to failure" may probably reflect the ability to maintain high coordination abilities under conditions of greater fatigue as a result of performing a higher load after PP. The statistically significant correlations that emerged after PP may indicate the formation of closer priority relationships between the indicators of cardio respiratory system, physical performance, and coordination of movements, which indicates an increase in the functional capabilities of the body, contributing to the growth of sports results.

Conclusions

The results of the study showed that the proposed program for the summer-autumn training period contributes to the improvement of the functional status of the cross-country skiers and to the development of physical power, endurance, increased strength of the upper limbs, increased speed of movement on roller skis, faster and more complete recovery of physiological and biochemical parameters. The proposed program for the summer-autumn training period helped in improving the athletes' functional status, and can be recommended for the development of physical qualities in highly qualified cross-country skiers and for improvement of physical performance.

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Conflict of interests

The authors declare no conflict of interest.

References

1. Losnegard T, Mikkelsen K, Rønnestad BR, Hallern J, Rud B, Raastad T. The effect of heavy strength training on muscle mass and physical performance in elite cross country skiers. *Scand J Med Sci Sports*. 2011; 21: 389–401. https://doi.org/10.1111/j.1600-0838.2009.01074.x
2. Losnegard T, Myklebust H, Spencer M, Hallén J. Seasonal Variations in VO_2max, O_2-Cost, O_2-Deficit, and Performance in Elite Cross-Country Skiers. *J. Strength Cond. Res*. 2013; 27(7): 1780–1790. https://doi.org/10.1519/JSC.0b013e31827368f6
3. Hedelin R, Wiklund U, Bjerle P, Henriksson-Larse´n K. Pre- and post-season heart rate variability in adolescent cross-country skiers. *Scand j med & Sci in Sport*. 2000; 6: 98–303. https://doi.org/10.1034/j.1600-838.2000.010005298.x
4. Beattie K, Kenny IC, Lyons M, Carson BP. The Effect of Strength Training on Performance in Endurance Athletes. *Sports Med*. 2014; 44:845–865. https://doi.org/10.1007/s40279-014-0157-y
5. Rønnestad BR, Mujika I. Optimizing strength training for running and cycling endurance performance: A review. *Scand J Med Sci Sports*. 2014; 24: 603–612. https://doi.org/10.1111/sms.12104
6. Choi Chul Y. The effect of 3 weeks high altitude skiing training on isokinetic muscle function of cross-country skiers. *J Korea Conv Soc*. 2018;9:465–77. https://doi.org/10.15207/JKCS.2018.9.11.465
7. Paavolainen L, Häkkinen K, Rusko H. Effects of explosive type strength training on physical performance characteristics in cross-country skiers. *Eur J Appl Physiol Occup Physiol*. 1991; 62: 251–255. https://doi.org/10.1007/BF00571548
8. Skattebo Ø, Hallén J, Rønnestad B R, Losnegard T. Upper body heavy strength training does not affect performance in junior female cross-country skiers. *Scand J Med Sci Sports*. 2016; 26(9):1007–16. https://doi.org/10.1111/sms.12517
9. Øfsteng S, Sandbakk Ø, van Beekvelt M, Hammarström D, Kristoffersen R, Hansen J, et al. Strength training improves double-poling performance after prolonged submaximal exercise in cross-country skiers. *Scand J Med Sci Sports,* 2018;28:893–904. https://doi.org/10.1111/sms.12990
10. Bojko ER. *Physiological and biochemical mechanisms to ensure the sports activities of winter cyclic sports*. Syktyvkar: LLC Komi republic printing office; 2019. (in Russian).
11. Lyudinina AYu, Ivankova GE, Bojko ER. Priority use of medium-chain fatty acids during high-intensity exercise in cross-country skiers. *J Int Soc Sports Nutr,* 2018;15:57. https://doi.org/10.1186/s12970-018-0265-4

12. Garnov IO, Varlamova NG, Loginova TP, Potolitsyna NN, Chernykh AA, Bojko ER. Effects of the maximal bicycle ergometric load test on coordination abilities and functional state of cross-country skiers and biathletes. *Russian Journal of Biomechanics*. 2019;2:143 – 150. https://doi.org/10.15593/RZh Biomeh/2019.2.01
13. Cross country skiing Federation of Russia. *RUS points.* [Internet]. 2020 [updated 2018 Jun 15; cited 2020 Nov 5]. (in Russian). Available from: http://www.flgr.ru/Results
14. Youdas JW, Amundson CL, Cicero KS, Hahn JJ, Harezlak DT, Hollman JH. Surface electromyographic activation patterns and elbow joint motion during a pull-up, chin-up, or perfect-pullup TM rotational exercise. *J Strength and Cond Res*. 2010; 24(12): 3404-3414. https://doi.org/10.1519/JSC.0b013e3181f1598c
15. Popov DV, Vinogradova OL. Comparison of the aerobic performance of leg and arm muscles in cross-country skiers. *Human Physiology.* 2012;38 (5): 508–513. https://doi.org/10.1134/S0362119712050106
16. Gilbert C. Optimal physical performance in athletes: key roles of dopamine in a specific neurotransmitter/hormonal mechanism. *Mech Ageing Dev.* 1995; 84: 83–102. https://doi.org/10.1016/0047-6374(95)01635-X
17. Bojko ER. Metabolic providing an annual cycle of adaptive reactions of cardiovascular and respiratory systems at the military personnel on north conditions. *Federal Research Centre Komi Science Centre of the Ural Branch of the Russian Academy of Sciences*. Syktyvkar; 2007. (in Russian).
18. Krivoschekov SG, Divert VE, Melnikov VN, Vodjanitskij SN, Girenko LA. Comparative analysis of gas exchange and cardiorespiratory system responses of swimmers and skiers to increasing normobaric hypoxia and physical load. *Human Physiology*. 2013; 39(1): 98–105. (in Russian). https://doi.org/10.1134/S0362119712060072
19. Gorbaneva EP. *Qualitative characteristics of functional preparedness of athletes*. Saratov: Sciencebook; 2008. (in Russian).
20. Popov DV, Vinogradova OL. Aerobic performance: role of oxygen delivery and utilization, glycolytic flux. *Progress in Physiological Science.* 2012; 43(1): 30–47. (in Russian).
21. Blomqvist CG, Saltin B. Cardio vascular adaptation to physical training. *Ann Rev Physiol.* 1983; 45:169–189. https://doi.org/10.1146/annurev.ph.45.030183.001125
22. Hashimoto T, Brooks GA. Mitochondrial Lactate Oxidation Complex and an Adaptive Role for Lactate Production. *Med Sci Sports Exerc*. 2008; 40(3): 486 – 494. https://doi.org/10.1249/MSS.0b013e31815fcb04
23. Jacobs I. Blood Lactate: Implications for Training and Sports Performance. *Sports Med.* 1986; 3(1):10–25. https://doi.org/10.2165/00007256-198603010-00003
24. Komi P, Ito A, Sjödin B, Wallenstein R, Karlsson J. Muscle Metabolism, Lactate Breaking Point, and Biomechanical Features of Endurance Running. *Int J Sports Med*, 1981; 2:148–53. https://doi.org/10.1055/s-2008-1034602
25. Lyakh VI. *Coordination skills: Diagnosis and development.* Moscow: TVT Divizion; 2006. (in Russian).

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ORIGINAL ARTICLE

The relationship of the development of motor skills and socioeconomic status of family with BMI of children with autism disorder

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Abstract

Purpose: This study aims to examine the relationship between the development of motor skills and the socio-economic status of families with body mass index (BMI) of children with autism disorder.

Material: To this end, 68 children with autism at the age range of 6-13 years old were selected for the study. Their parents completed Family Socioeconomic Status Questionnaire. The motor skills level of children was measured by the Movement Assessment Battery for Children (MABC). The height and weight of children were measured to calculate their BMI. The results of the Pearson correlation test showed that there is a significant and negative relationship between the development of motor skills and the socioeconomic status of families with BMI of children with autism.

Results: The results of the linear regression test also indicated that motor development and family socioeconomic status are predictors of BMI in people with autism (P<0.05).

Conclusions: It is concluded that the socioeconomic status of the family and the motor development of children with autism are the determinants of their overweight and obesity and these factors should be considered in the interventions for children and families.

Keywords: gross motor skill, fine motor skill, BMI

Introduction

Overweight and obesity have become one of the global challenges of the current era. While the global prevalence of overweight and obesity in children has been reported as 6.7% [1], some reports indicate the higher prevalence of obesity in mentally retarded people [2] and those with developmental disorders [3]. This is a concern because it exacerbates the problems of these people. Autism prevalence in children with autism is 22.2%. They are 41.1% more likely to suffer obesity [4].

Overweight and obesity in children are usually related to medical (type II diabetics) or mental (depression) comorbidities [5, 6]. Consequently, the increase in weight and obesity in children with autism can harm their quality of life, increase the costs, and lead to more exhaustion of their parents [7]. In the US, the cost of living of people suffering from autism is 1.4 to 2.4 million dollars during the lifespan. To this end, it is important to find some solutions to these problems and prevent them.

Physical activity, sleep, motor skills levels and sedentary behaviors are among the important and effective factors of childhood obesity [8]. The previous studies showed that people with autism have basic problems in motor skills, in addition to problems in speaking, social communication and eye contact [9, 10]. Barrodi et.al indicated that children with autism have a low-performance level in motor skills. It is worthy to mention that the failure in motor skills has been seen in these children at low ages and before one-year-old [11]. This leads to the assumption that maybe one of the reasons for increasing BMI is the failure in motor skills and lack of enough physical activity in these people. Studies about healthy people have shown that there is a significant relationship between BMI and motor skills. For example, D'Hondt et.al [5] showed that obscene and overweight children have more weak performance than their peers. Di Mister et.al [6] indicated that children with lower motor skill levels show more tendency to increase in weight and easily become obscene.

On the other hand, one of the effective factors on the BMI of children is the socio-economic status of their families [8]. In a study in South Africa, it was shown that children from different socio-economic classes require the prescription of physical activity [7] while the previous studies in countries with higher incomes confirmed the opposite [12, 13]. There is not yet a comprehensive study to determine the relationship between socio-economic status and motor skills level with BMI, despite the necessity of controlling weight in people with autism disorder. As a result, the current study seeks to answer that is there a relationship between socio-economic status and motor skill levels and BMI? Can we predict BMI by using these variables?

Material and Methods

Participants

In this study, 68 children with autism in the age range of 3-16 years old (mean=8.27, SD=3.20) were selected and studied by referring to education and rehabilitation centers for children with autism in Mashhad city.

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The inclusion criteria were suffering autism disorder confirmed by psychiatrists, lack of comorbidities like hyperactivity, mental retardation, musculoskeletal problems, cardiovascular disease, and epilepsy. All parents signed the informed consent forms after becoming aware of the study procedure.

Research Design.

Tools

Movement Assessment Battery for Children-Second Edition (MABC-2)

It is one of the most widely used and common tests for measurement and diagnosis of motor disorders in children that measures fine motor skills, gross motor skills, and motor proficiency of an individual [14]. It has a defined norm and it is used for 3-17years old age range. This test is the result of two decades of research by Henderson et.al [15] and has three age ranges: 3-6 years old, 7-10 years old, and 11-17 years old. This battery consists of a checklist and descriptive instruction to diagnose children with motor coordination disorder. This test includes a set of gross and fine motor tasks. Tasks divide into three sections: 1) manual dexterity skill (including skills like placing pegs, threading and drawing a maze), 2) aiming and catching (catching and throwing beanbag), and 3) balance skill (one-leg balance, walking heels raised, hopping). The total test time is about 20 to 40 minutes [14]. This test has been validated in Iran by Akbaripour et.al [16] and its Cronbach alpha is 0.843.

Family Socioeconomic Status Questionnaire

A socioeconomic status questionnaire was used to measure the socioeconomic status of children. This questionnaire has four items: income, economic class, education, and housing. It consists of 6 demographic questions and 5 main questions. The measurement scale for questions in this questionnaire was the five-point scale and the scoring is from very low=1 to very high=5.

Face and content validities of the given questionnaire confirmed by 12 experts. Its reliability with Cronbach alpha was 0.83.

Procedure

After coordination with centers and parents of the participants, the selected children were examined by motor behavior experts by MABC-2. This test was conducted in a calm setting by the cooperation of the teachers in the education center of children to avoid the effects of a new setting on the performance of the participants. Parents and teachers responded to the socioeconomic status questionnaire. The raw scores of both tests converted to standard scores and related coefficients by experts, using the norms and related instructions and applied in the statistical analysis.

Statistical Analysis

Pearson correlation test was used to determine the relationship between the variables of the study. Linear regression was also used to determine the predictability of subjects' BMI scores from their motor skill scores and socioeconomic status. All statistical tests were conducted by SPSS software Version 23 in $\alpha=0.05$ statistical level.

Results

Table 1 indicates the demographic information of the subjects.

The results of this study showed that from among participants in this study, 22.9% suffer low weight and 31.4% suffer overweight. 54.7% have normal weight. The information obtained from the socioeconomic status of families shows that 28.6% of them are in a low class, 68.6% are in the middle class and only 2.9% are in high class. 92.9% of children were in a low class, 2.9% in the middle class, and 4.3% in high class in terms of motor development.

Results of the Pearson correlation test showed that there is a negative significant relationship between families' socioeconomic status and BMI in children with autism ($r=0.781$, $p=0.001$). There is also a negative significant between fine motor skills ($r=0.858$, $p=0.001$), gross motor skill ($r=0.781$, $p=0.001$) and motor proficiency ($r=0.866$, $p=0.001$).

Multiple linear regression was used to determine the likelihood of predicting autism severity by motor skills that the results are presented in Table 2.

Table 1. Demographic information of subjects

Variable	Minimum	Maximum	Standard deviation	Mean
Age (year)	3.10	16.80	3.20	8.27
Height (m)	1.02	1.65	0.16	1.26
Weight (kg)	1.76	140	20.56	41.07
BMI	15.35	75.46	9.82	25
Socioeconomic status	6	21	3.47	12.42
Autism severity	66	151	17.65	96.61
Fine skill	1	9	1.96	3.41
Gross skill	2	22	4.86	6.67
Motor proficiency	6	66.5	15.18	28.72

Table 2. Regression analysis for predicting autism severity from motor skills

Model	Sum of squares	Degree of freedom	Mean squares	F	R	R^2	R^2_{adj}	Sig.
Regression	1877.63	4	469.40	133.22	0.944	0.891	0.885	0.001
Remained	229.02	65	3.52					
Total	2106.65	69						

Table 3. Standard and non-standard coefficients and t-statistics inserted in the regression model

Predictor variable	Regression coefficients		t-statistic	Sig.
	B	Beta		
Fixed value	28.94		12.66	0.001
Socioeconomic level	0.414	0.261	3.54	0.001
Fine motor skill	-2.86	-1.01	-5.67	0.001
Gross motor skill	1.69	1.49	7.49	0.001
Motor proficiency	-0.411	-1.12	-4.65	0.001

As seen in Table 3, the regression model is significant. R^2adj also shows that fine motor skills, gross motor skills, and motor proficient subscales can predict BMI up to 88%. Then, it was observed that the socioeconomic level, fine motor skill, gross motor skill, and motor proficiency can predict the BMI of participants.

The results obtained in table 3 indicate that socioeconomic level with regression (0.261), fine motor skill (-1.01), gross motor skill (1.49), and motor proficiency (1.12) are capable of predicting BMI of participants. Indeed, this coefficient indicates that by increasing the predictor factors, the BMI of participants reduces.

Discussion

This study aimed to examine the relationship between the socioeconomic status of the family and the motor proficiency of BMI in children with autism. The obtained results indicated that about one-third of children with autism suffer overweight and obesity. In other words, the prevalence of obesity in these children is high. These results are consistent with the results of previous studies [1, 3, 4]. Memari et.al [3] showed that 13.3% of people participating in their study have overweight, 11.5% were obscene and 15.9% suffered hyperadiposis. Another part of the results of this study indicated that children with autism are very weak in motor proficiency. These results were also in line with previous findings [9, 10, 17]. Bricout et.al [18] showed that people with autism are different from the control group in motor skills like handicrafts and rolling the ball. It should be noted that children with autism are different from healthy children in motivations and their performance will be weak if they have not enough motivation [19].

The main part of the results of this study emphasizes the relationship between the socioeconomic status of the family and motor proficiency with BMI. The results of this study showed that there is a positive and significant relationship between family socioeconomic status and BMI. This means that by increasing the social welfare of the family, we witness overweight and obesity in children with autism. These results are in line with the results obtained for healthy people. As previous studies have shown, the modern lifestyle and increase the sedentary behavior have increased the risk of overweight and obesity in children. Besides, the results of this study confirm the results of previous studies in western countries that education of parents has an inverse relationship with overweight and obesity in children [20, 21]. The socioeconomic status of the family includes the education and income of the family. It seems that families with higher socioeconomic levels have higher educations. This will lead to paying more attention to the motor activities and motor interventions for the children and these parents have somehow used sport and physical activity to cope with the overweight and obesity of their children. They have also taken some steps toward healthy nutrition due to their higher education level because there is a direct relationship between nutrition and physical activity with BMI. In other words, unhealthy and high-calorie diet leads to overweight and obesity in children [4, 21]. It is also likely that families with lower income use medications instead of motor interventions and sports classes because the medications are covered by insurance and they pay less cost. Using medications is accompanied by complications like overweight and obesity in children with autism [3]. As a result, it is suggested that the insurance-related bodies and supporting organizations provide sport and motor rehabilitation services insurance for families with autistic children.

The other parts of the results of this study showed that there is a significant relationship between motor skills level of children with autism and their BMI. These results confirm the results of the previous section because as said the low-income level of family prevents them to provide motor interventions for their children. Many of them try to spend their medical costs for the required interventions for their children such as speech therapy and mental occupational therapy and they neglect the importance of developing motor skills [9, 19]. Failure in motor skills in children, especially children with autism, can isolate and limit them [2]. This failure can lead them toward sedentary behavior that exacerbates their overweight and obesity [2, 19, 22]. Gross motor skills consist of skills such as running, throwing, catching, hopping, and trotting. These motor movements are the basis for a large number of games and sports activities. Enough development of gross motor skills will provide more motivation to participate in physical activity and the family will also show more tendency to use motor interventions and sport [19]. If the gross motor skill has done continuously and in the long-term, it will increase the calorie consumption and prevent obesity because it involves the large muscles of the body.

Conclusion

Regarding the results of this study, it can be concluded that the socioeconomic status of families with autistic children is a very important and effective factor for their BMI because it determines their lifestyles. This lifestyle will show them to either follow the medical solutions and medications or active lifestyle and physical interventions and sport.

Conflict of interest

Authors declare no conflict of interest.

References

1. De Onis M, Blössner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. *The American Journal of Clinical Nutrition*. 2010;92(5):1257–64. https://doi.org/10.3945/ajcn.2010.29786
2. Sulton K, Jajat J. Relationship between Gross Motor Skills and Body Mass Index of Children with Intellectual Disability. *Proceedings of the 3rd International Conference on Sport Science, Health, and Physical Education (ICSSHPE 2018)*, Bandung, Indonesia: Atlantis Press; 2019. https://doi.org/10.2991/icsshpe-18.2019.60
3. Memari AH, Kordi R, Ziaee V, Mirfazeli FS, Setoodeh MS. Weight status in Iranian children with autism spectrum disorders: Investigation of underweight, overweight and obesity. *Research in Autism Spectrum Disorders*. 2012;6(1):234–9. https://doi.org/10.1016/j.rasd.2011.05.004
4. Kahathuduwa CN, West BD, Blume J, Dharavath N, Moustaid-Moussa N, Mastergeorge A. The risk of overweight and obesity in children with autism spectrum disorders: A systematic review and meta-analysis. *Obesity Reviews*. 2019;20(12):1667–79. https://doi.org/10.1111/obr.12933
5. D'Hondt E, Deforche B, De Bourdeaudhuij I, Lenoir M. Childhood obesity affects fine motor skill performance under different postural constraints. *Neuroscience Letters*. 2008;440(1):72–5. https://doi.org/10.1016/j.neulet.2008.05.056
6. De Meester A, Stodden D, Brian A, True L, Cardon G, Tallir I, et al. Associations among elementary school children's actual motor competence, perceived motor competence, physical activity and BMI: A cross-sectional study. *PloS One*. 2016;11(10):e0164600. https://doi.org/10.1371/journal.pone.0164600
7. Draper CE, Tomaz SA, Stone M, Hinkley T, Jones RA, Louw J, et al. Developing intervention strategies to optimise body composition in early childhood in South Africa. *BioMed Research International*. 2017;2017. https://doi.org/10.1155/2017/5283457
8. Tomaz SA, Prioreschi A, Watson ED, McVeigh JA, Rae DE, Jones RA, et al. Body mass index, physical activity, sedentary behavior, sleep, and gross motor skill proficiency in preschool children from a low-to middle-income urban setting. *Journal of Physical Activity and Health*. 2019;16(7):525–32. https://doi.org/10.1123/jpah.2018-0133
9. Ament K, Mejia A, Buhlman R, Erklin S, Caffo B, Mostofsky S, et al. Evidence for specificity of motor impairments in catching and balance in children with autism. *Journal of Autism and Developmental Disorders*. 2015;45(3):742–51. https://doi.org/10.1007/s10803-014-2229-0
10. Fournier KA, Hass CJ, Naik SK, Lodha N, Cauraugh JH. Motor coordination in autism spectrum disorders: a synthesis and meta-analysis. *Journal of Autism and Developmental Disorders*. 2010;40(10):1227–40. https://doi.org/10.1007/s10803-010-0981-3
11. Arabameri E, Sotoodeh MS. Early developmental delay in children with autism: a study from a developing country. *Infant Behavior and Development*. 2015;39:118–23. https://doi.org/10.1016/j.infbeh.2015.02.017
12. Hesketh KR, McMinn AM, Ekelund U, Sharp SJ, Collings PJ, Harvey NC, et al. Objectively measured physical activity in four-year-old British children: a cross-sectional analysis of activity patterns segmented across the day. *International Journal of Behavioral Nutrition and Physical Activity*. 2014;11(1):1. https://doi.org/10.1186/1479-5868-11-1
13. Chaput J-P, Colley RC, Aubert S, Carson V, Janssen I, Roberts KC, et al. Proportion of preschool-aged children meeting the Canadian 24-Hour Movement Guidelines and associations with adiposity: results from the Canadian Health Measures Survey. *BMC Public Health*. 2017;17(5):147–54. https://doi.org/10.1186/s12889-017-4854-y
14. Brown T, Lalor A. The movement assessment battery for children–second edition (MABC-2): a review and critique. *Physical & Occupational Therapy in Pediatrics*. 2009;29(1):86–103. https://doi.org/10.1080/01942630802574908
15. Henderson SE, Sugden DA, Barnett AL. *Movement Assessment Battery for Children-2*. second edition (Movement ABC-2). London: The Psychological Corporation. 2007.
16. Akbaripour R, Daneshfar A, Shojaei M. Reliability of the Movement Assessment Battery for Children-(MABC-2) in children aged 7-10 years in Tehran. *Rehab Med*. 2018;7(4):90–6. https://doi.org/10.22037/jrm.2018.111121.1776
17. Colombo-Dougovito AM, Reeve RE. Exploring the interaction of motor and social skills with autism severity using the SFARI dataset. *Perceptual and Motor Skills*. 2017;124(2):413–24. https://doi.org/10.1177/0031512516689198
18. Bricout V-A, Pace M, Dumortier L, Miganeh S, Mahistre Y, Guinot M. Motor Capacities in Boys with High Functioning Autism: Which Evaluations to Choose? *Journal of Clinical Medicine*. 2019;8(10):1521. https://doi.org/10.3390/jcm8101521
19. Case L, Schram B, Yun J. Motivating Children with Autism Spectrum Disorder in Gross Motor-skill Assessments. *Journal of Physical Education, Recreation & Dance*. 2019;90(4):32–8. https://doi.org/10.1080/07303084.2019.1568933
20. Shrewsbury V, Wardle J. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990–2005. *Obesity*. 2008;16(2):275–84. https://doi.org/10.1038/oby.2007.35
21. Bammann K, Gwozdz W, Lanfer A, Barba G, De Henauw

S, Eiben G, et al. Socioeconomic factors and childhood overweight in Europe: results from the multi-centre IDEFICS study. *Pediatric Obesity*. 2013;8(1):1–12. https://doi.org/10.1111/j.2047-6310.2012.00075.x

22. Holloway JM, Long TM, Biasini F. Relationships Between Gross Motor Skills and Social Function in Young Boys With Autism Spectrum Disorder. *Pediatric Physical Therapy*, 2018:1. https://doi.org/10.1097/PEP.0000000000000505

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ORIGINAL ARTICLE

Academic and sport achievements of the physical culture and sports university students

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Purpose: It is widely used a paradigm about the interdependence between the academic and sport achievements of students. The aim of this research was to create a model for studying relationships between academic and sport achievements of the sports and physical culture university students.

Material: Totally 259 (168 male and 91 female) bachelor students of 18–23 years old studied Physical Culture and Sports were involved into the investigation. All the students were good healthy, and they participated in the sport training and competitions, according to the common program. Interdependence between the semester control scores and scores of the sport achievements were studied in the frames of correlation models of parameter and non-parameter statistics. Distribution of scores was studied using Kolmogorov – Smirnov method. One-way ANOVA for repeated measures was used to determine differences between students' scores and educational disciplines' scores.

Results: Almost non-significant weak interdependence between results of semester control and sport achievements was noticed ($p>0.05$, $0.174 \le r_s \le 0.284$). There were no statistically significant and tight correlation between semester control scores of educational disciplines and corresponding sport achievements scores ($|r_s| \le 0.376$). Contrary, in 73% of educational disciplines pairs the semester control scores showed significant and tight correlation ($p<0.001$, $0.385 \le r \le 0.895$).

Conclusions: A well-known paradigm about significant relationship between academic and sport achievements of students was not confirmed with the results of this research and should be studied more profoundly.

Keywords: bachelor, education, scores, correlation, testing, model.

Introduction

In the sports and physical culture pedagogy, there is a well-known paradigm regarding the academic and sport achievements. It is widely used an idea about the interdependence between the academic and sport achievements of students. Quantitative methods for assessment of the motivation factors for professional sport activity were developed regarding the problem [1]. The investigation of the relationship between academic and sport motivation orientations of the physical education college students led to a positive statistically significant result [2, 3]. There is a positive correlation between the motivation of achievement and the tendency towards studying physical education [4, p. 432]. Sierra-Diaz et al. published a systematic review and meta-analysis of psychosocial factors related to physical education motivates students to practice physical activities and sports through models-based practice. They described implementation of cooperative learning, constraint-led approach, games-cantered approach, sport education model, hybridizations, autonomy-supportive climate and their impact on the students' motivation [5].

There are a lot of research on the problem of sport achievements motivation and physical education involvement. Burgueno et al. examined the influence of an intervention based on Sport Education Model, in comparison with traditional teaching model, on motivational regulation in high school students in Physical Education class [6, p. 87]. Self-determined motivation and state of flow in an extracurricular program of small-sided games were studied [7] and adopting of a models-based approach to teaching physical education was investigated [8]. Corresponding research are based on the constraint-led approach to sport and physical education pedagogy and spread a wide range of pupils and students in different ages [9]. Navarro-Paton et al. derived a relation between motivation and enjoyment in physical education classes in children from 10 to 12 years old [10]. Influence of a sport education season on motivational strategies in high school students taking into account a self-determination theory-based perspective was investigated by Medina et al. [11]. Kolovelonis and Goudas determine the relation of physical self-perceptions of competence, goal orientation, and optimism with students' performance calibration in physical education [12].

The way to increase the motor and sport competence among children was found using the contextualized sport alphabetization model [13, 14]. Associations among basic psychological needs, motivation and enjoyment within Finnish physical education students were studied by Huhtiniemi et al. [15]. Hartwig et al. created a monitoring system to provide feedback on student physical activity during physical education lessons [16].

In all the presented above publications, academic and sport motivations orientations of students were studied using questionaries' methods. Academic motivation scale

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and sport motivation scale were applied to measure the data for correlation analysis. These results are useful and practical, but do not obtain a straight consideration of the paradigm about academic and sport achievements of students because they are subjective, i.e. produced by subjects. The results present what subjects know, what they want, plan, consider etc. Contrary, we did not find research operated with objective data measured academic and sport achievements of students. Such results should not be depended on the subjects, i.e. students.

Research hypothesis. There is a significant straight correlation between academic and sport achievements of the sports and physical culture university students.

Purpose. The aim of this research was to create a model for studying relationships between academic and sport achievements of the sports and physical culture university students.

Material and Methods

Participants

Totally 259 bachelor students of 18–23 years old studied Physical Culture and Sports were involved into the investigation. They were 168 male students with body length 177.2±4.7 cm and body mass 74.1±3.8 kg (M±SD) and 91 female students with body length 164.7±4.2 cm and body mass 61.2±3.1 kg). All the students were good healthy, and they participated in the sport training and competitions, according the common program [17]. This study was approved in advance by Ethical Committee of Lviv State University of Physical Culture. Students voluntarily provided written informed consent before participating. The procedures followed were in accordance with the ethical standards of Helsinki Declaration on human experimentation.

Procedure

Results of the winter semester control of 2019 – 2020 academic year were taken into consideration. Academic achievements were determined as scores of 100 points academic scale regarding all the educational disciplines [18, p. 2]. Sport achievements were determined as scores of 100 points sport scale [19, p. 4].

Statistical analysis

Interdependence between the semester control scores and scores of the sport achievements were studied in the frames of correlation models of parameter (Pearson [20]) and non-parameter (Spearman [21]) statistics. Statistical significance of correlation was determined using t-Student parameter. Distribution of scores was studied using Kolmogorov – Smirnov method [22]. One-way ANOVA for repeated measures was used to determine variations between students' scores and between educational disciplines' scores [23].

Statistical elaboration of scores was done using on-line package of computer programs Social Science Statistics [24] and Data Analysis Adon of MS Excel [25].

Results

Because sport scale scores did not meet normal distribution in all of the four years ($p \le 0.039$), relationship between academic and sport scores was determined using Spearman correlation coefficient [21] (Table 1).

Between the semester control average scores and corresponding sport achievements scores, weak (1st, 2nd, and 3rd years) and very weak (4th year) correlation was noticed ($0.174 \le r_s \le 0.284$). On the second and fourth years, significance of correlation was low ($p>0.165$), and on the first year – a little beat lower than it is widely used ($p>0.05$). Only on the third year, quit weak significant correlation was noticed on the near sufficient level $p=0.054$ (see table 1). Totally, on the four bachelor years, almost non-significance interdependence between results of the semester control and sport achievements was noticed. Besides the average scores, correlation analysis was done between sport achievements scores and separate educational disciplines scores (Table 2).

Statistically significant correlation between sport achievements scores and semester control scores was noticed for Kinesiology, Physiology of sports, and Biochemical basis of sports ($p<0.022$). The tightness of correlation for these three educational disciplines was low (see Table 2). One can turn his attention to the clear superiority of the correlation tightness of sport achievements scores with scores of medicine and biology educational disciplines (Kinesiology, Physiology of sports, and Biochemical basis of sports) relatively the sport disciplines (Theory and methods of sports,

Table 1. Average score of the semester control / Scores of sport achievement

Statistics*	Year			
	1	2	3	4
n	48	52	64	43
90th percentile	99.0 / 51.0	98.0 / 60.0	89.0 / 50.0	93.0 / 50.0
Me	91.5 / 30.0	90.0 / 30.0	80.0 / 30.0	87.0 / 20.0
10th percentile	81.8 / 0.0	82.9 / 10.0	66.0 / 20.0	76.0 / 10.0
D	0.255 / 0.253	0.147 / 0.285	0.162 / 0.245	0.139 / 0.214
p(D)	0.085 / 0.006	0.227 / 0.001	**0.079** / 0.001	0.372 / **0.039**
r_s	0.284	0.203	0.263	0.174
$p(r_s)$	0.062	0.166	**0.054**	0.277

* n – number, Me – median, D – Kolmogorov – Smirnov statistics, p – significance; r_s – Spearman coefficient

Theory and methods of physical education, Introduction into specialty, Defence of the coaching practice, and Organization of physical culture).

Because the semester control disciplines scores distributions were rather similar to normal distribution ($p \geq 0.079$, see Table 1), the analysis of relationships between scores of separate educational disciplines was undertaken using Pearson correlation model [20] (Tables 3-6).

Rather significant correlation ($0.001 \leq p < 0.01$) on the second year was noticed between results of Psychology of sports and Theory and methods of sports (p=0.004), results of Pedagogics and Theory and methods of sports (p=0.001), and between results of Theory and methods of gymnastics and Theory and methods of sports (p=0.006, see Table 4).

On the third year, fairly significant correlation was noticed between results of Foreign language and Economic theory (p=0.009). On the fourth year, significant correlation was noticed between results of Defence of the coaching practice and Economy of sports (p=0.007, see Table 5) and between scores of Organization of physical culture and Defence of the coaching practice (p=0.008, see Table 6).

Statistically sufficient significance correlation ($0.01 \leq p < 0.05$) was noticed on the third year between scores of Foreign language and Theory and methods of physical education (p=0.025), and on the fourth year – between results of Defence of the coaching practice and Common theory of the professional sports (p=0.012). Statistically non-sufficient significance correlation ($p \geq 0.05$) was noticed between scores results of Defence of the coaching practice and Theory and methods of sports (p=0.084), as well, as between results of Theory and methods of sports and Common theory of the professional sports (p=0.309).

Totally, on all the bachelor years (see Tables 3-6), between semester control scores of educational disciplines in prevailing number comparisons (28 from 38 pairs) statistically high significance ($p < 0.001$) of tight correlation ($0.385 \leq r \leq 0.895$) was revealed.

As a result of one-way ANOVA for repeated measures significant differences between individual students' scores and educational disciplines' scores were determined ($p < 0.001$). The biggest relative variation between semester control scores was noticed among educational disciplines in the first year (43.4%): Theory and methods of sports, History of Ukraine, and Introduction into specialty, and the smallest – in the second year (17.5%): Theory and methods of sports, Physiology of sports, Pedagogics, Theory and methods of track and field, and Theory and methods of gymnastics. The biggest relative variation between student's semester control scores was noticed in the second year (82.5%) and the smallest – in the first (56.6%).

Table 2. Correlation between the educational disciplines scores semester control and sport achievements scores

Years	Educational disciplines	r_s	$p(r_s)$
1	Theory and methods of sports	0.283	0.051
	Introduction into specialty	0.123	0.404
2	Theory and methods of sports	0.260	0.063
	Psychology	0.022	0.875
	Pedagogics	0.045	0.751
	Theory and methods of track and field	0.074	0.600
	Theory and methods of gymnastics	0.096	0.500
3	Theory and methods of physical education	-0.022	0.861
	Kinesiology	0.327	0.005
	Physiology of sports	0.270	0.021
	Biochemical basis of sports	0.376	0.001
4	Defence of the coaching practice	0.064	0.683
	Theory and methods of physical education	-0.063	0.686
	Organization of physical culture	0.220	0.156

Table 3. Correlation table of the educational disciplines scores on the semester control of 1st year: r-Pearson \ t-Student

Educational disciplines	Theory and methods of sports	History of Ukraine	Introduction into specialty
Theory and methods of sports	◊	4.268	3.716
History of Ukraine	0.492***	◊	8.803
Introduction into specialty	0.442***	0.759***	◊

◊n=59, ***p<0.001, t(0.001, 57) = 3.470

Table 4. Correlation table of the educational disciplines scores on the semester control of 2nd year: r-Pearson \ t-Student

Educational disciplines	Theory and methods of sports	Physiology of sports	Pedagogics	Theory and methods of track and field	Theory and methods of gymnastics
Theory and methods of sports	◊	2.960	3.344	4.522	2.860
Physiology of sports	0.362**	◊	12.300	10.173	15.265
Pedagogics	0.402**	0.850***	◊	7.911	10.722
Theory and methods of track and field	0.511***	0.801***	0.720***	◊	13.408
Theory and methods of gymnastics	0.352**	0.895***	0.815***	0.870***	◊

◊n=60, **p<0.01, ***p<0.001, t(0.01, 58) = 2.663, t(0.001, 58) = 3.466

Table 5. Correlation table of the educational disciplines scores on the semester control of 3rd year: r-Pearson \ t-Student

Educational disciplines	Kinesiology	Foreign language	Economic theory	Physiology of sports	Biochemical basis of sports	Theory and methods of physical education
Kinesiology	◊	3.727	11.028	6.838	5.788	12.327
Foreign language	0.385***	◊	2.648	4.345	7.564	2.287
Economic theory	0.777***	0.284**	◊	6.649	5.249	13.742
Physiology of sports	0.607***	0.437***	0.597***	◊	9.470	5.817
Biochemical basis of sports	0.543***	0.646***	0.506***	0.727***	◊	4.709
Theory and methods of physical education	0.809***	0.248*	0.838***	0.545***	0.466***	◊

◊n=82, *p<0.05, **p<0.01, ***p<0.001, t(0.05, 80) = 1.990, t(0.01, 80) = 2.639, t(0.001, 80) = 3.416

Table 6. Correlation table of the educational disciplines scores on the semester control of 4th year: r-Pearson \ t-Student

Educational disciplines	Defence of the coaching practice	Theory and methods of sports	Organization of physical culture	Common theory of the professional sports	Economy of sports
Defence of the coaching practice	◊	1.757	2.698	2.584	2.821
Theory and methods of sports	0.229	◊	3.866	1.026	5.365
Organization of physical culture	0.339**	0.459***	◊	7.797	10.268
Common theory of the professional sports	0.326*	0.136	0.721***	◊	4.477
Economy of sports	0.353**	0.583***	0.808***	0.513***	◊

◊n=58, *p<0.05, **p<0.01, ***p<0.001, t(0.05,56) = 2.003, t(0.01,56) = 2.667, t(0.001,56) = 3.473

Discussion

According to the aim of this research, a model for studying relationships between academic and sport achievements of the sports and physical culture university students was created using parametric and non-parametric correlation of scores in 100 points scales educational disciplines semester control and regarding sport achievements [18, 19]. Unlike well-known models described sport motivations orientations of students based on the questioning [26, 27], the proposed in this paper model uses scores independent of subjective evaluation of students regarding their individual achievements.

It is interesting to notice that correlation tightness (r_s=0.270 – 0.376, p≤0.021) of sport achievements scores with scores for medicine and biology educational disciplines (Kinesiology, Physiology of sports, and Biochemical basis of sports) was found significantly greater than corresponding correlation tightness (p>0.05) for the sport educational disciplines (Theory and methods of sports, Theory and methods of physical education, Introduction into specialty, Defence of the coaching practice, and Organization of physical culture).

The model has very strong resolution because ANOVA for repeated measures showed significant differences as between individual students' scores and educational disciplines' scores as well (p<0.001). It is will be useful for individual evaluation of academic and sport achievement of Physical Culture and Sports university students as well, as students of another specialities and students at preparatory schools [28, 29]. The model was created and evaluated using results of semester control a sample of male and female students because scales used in the model were intended to male students and female students ignoring gender differences. However, in well-known scientific publications sport motivations orientations of students were studied taking into consideration genders [4, 26]. Therefore, influence of genders should be a research problem for future investigations of the proposed methods.

There were no statistically significant and tight correlation between semester control scores of educational disciplines and corresponding sport achievements scores ($|r_s|$≤0.376). Contrary, in 73% of educational disciplines pairs the semester control scores showed significant and tight correlation (p<0.001, 0.385≤r≤0.895).

Use of the on-line package of computer programs Social Science Statistics [24] and Data Analysis Adon of MS Excel [25] computer packet as a mathematical instrument of studying relationship between semester control and sport achievements scores make possible to use this model for teachers of physical culture and coachers which are not familiar with mathematical modelling.

Conclusions

A research hypothesis regarding significant straight correlation between semester control scores of academic and sport achievements of the sports and physical culture university students was rejected on the sufficient statistical level (p>0.05). Therefore, a well-known paradigm in physical culture and sports about significant relationship between academic and sport achievements of students was not confirmed with the results of this research and should be studied more profoundly.

Highlights

There were no statistically significant and tight correlation between semester control scores of educational disciplines and corresponding sport achievements scores ($|r_s|$≤0.376). Contrary, in 73% of educational disciplines pairs the semester control scores showed significant and tight correlation.

A well-known paradigm in physical culture and sports about significant relationship between academic and sport achievements of students was not confirmed with the results of this research and should be studied more profoundly.

One can turn his attention to the clear superiority of the correlation tightness of sport achievements scores with scores of medicine and biology educational disciplines (p≤0.021) relatively the sport disciplines (p>0.05).

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Conflict of Interest

The authors declare that there is no conflict of interest regarding this research.

References

1. Bondarenko MP. Assessment of the motivation factors for professional sport activity. *Middle-East Journal of Scientific Research,* 2013; 14 (9): 1221–1225. https://doi.org/10.5829/idosi.mejsr.2013.14.9.2227
2. Turkmen M. Investigation of the Relationship between Academic and Sport Motivation Orientations. *Middle-East Journal of Scientific Research,* 2013; 16 (7): 1008–1014. https://doi.org/10.5829/idosi.mejsr.2013.16.07.765
3. Turkmen M, Bozkus T, Altintas A. The relationship between motivation orientations and competitive anxiety in Bocce players: Does gender make a difference? *Psychology and Behavioral Sciences,* 2013; 2 (4): 162–168. https://doi.org/10.11648/j.pbs.20130204.12
4. Mahmoud MAAE. Preparatory school students' attitudes towards physical education lessons and its relationship to sport achievement motivation in Al Fayoum governorate. *World Journal of Sport Sciences,* 2012; 6 (4): 432–440.

https://doi.org/10.5829/idosi.wjss.2012.6.4.1158
5. Sierra-Díaz MJ, González-Víllora S, Pastor-Vicedo JC, López-Sánchez GF. Can We Motivate Students to Practice Physical Activities and Sports Through Models-Based Practice? A Systematic Review and Meta-Analysis of Psychosocial Factors Related to Physical Education. *Front Psychol*, 2019;10:2115. https://doi.org/10.3389/fpsyg.2019.02115
6. Aelterman N, Vansteenkiste M, Van-Keer, Van den Berghe L, De-Meyer J, Haerens L. Students' objectively measured physical activity levels and engagement as a function of between-class and between-student differences in motivation toward physical education. *J. Sport Exerc. Psychol*. 2012; 34: 457–480. https://doi.org/10.1123/jsep.34.4.457
7. Carrasco-Beltran HJ, Reigal RE, Fernandez-Uribe S, Vallejo-Reyes F, Chirosa-Rios LJ. Self-determined motivation and state of flow in an extracurricular program of Small-Sided Games. *An. Psicol*. 2018; 34: 391–397. https://doi.org/10.6018/analesps.34.2.258621
8. Casey A, MacPhail A. Adopting a models-based approach to teaching physical education. *Phys. Educ. Sport Pedag*. 2018; 23: 294–310. https://doi.org/10.1080/17408989.2018.1429588
9. Renshaw I, Chow JY. A constraint-led approach to sport and physical education pedagogy. *Phys. Educ. Sport Pedag*. 2019; 24: 103–116. https://doi.org/10.1080/17408989.2018.1552676
10. Navarro-Paton R, Lago-Ballesteros J, Basanta-Camino S, Arufe-Giraldez V. Relation between motivation and enjoyment in physical education classes in children from 10 to 12 years old. *J. Hum. Sport Exerc*. 2018; 1: 1–11. https://doi.org/10.14198/jhse.2019.143.04
11. Medina-Casaubon J, Burgueno R. Influence of a sport education season on motivational strategies in high school students: a self-determination theory-based perspective. *Ebm. Recide*. 2017; 13: 153–166. https://doi.org/10.1186/1479-5868-8-78
12. Kolovelonis A, Goudas M. The relation of physical self-perceptions of competence, goal orientation, and optimism with students' performance calibration in physical education. *Learn. Individ. Differ*. 2018; 61: 77–86. https://doi.org/10.1016/j.lindif.2017.11.013
13. Gonzalez-Víllora S, Sierra-Diaz MJ, Pastor-Vicedo JC, Contreras-Jordán OR. The way to increase the motor and sport competence among children: the Contextualized Sport Alphabetization model. *Front. Physiol*. 2019; 10: 569. https://doi.org/10.3389/fphys.2019.00569
14. Gonzalez-Villora S, Evangelio C, Sierra-Diaz J, Fernandez-Rio J. Hybridizing Pedagogical models: a systematic review. *Eur. Phys. Educ. Rev*. 2018; 20: 1–19. https://doi.org/10.1177/1356336X18797363
15. Huhtiniemi M, Saakslahti A, Watt A, Jaakkola T. Associations among basic psychological needs, motivation and enjoyment within finnish physical education students. *J. Sport Sci. Med*. 2019; 18: 239–247.
16. Hartwig TB, Pozo-Cruz B, White RL, Sanders T, Kirwan M, Parker PD, et al. A monitoring system to provide feedback on student physical activity during physical education lessons. *Scand. J. Med. Sci. Sports*. 2019; 29: 1305–1312. https://doi.org/10.1111/sms.13438
17. *Bachelor Educational Program. Speciality 017 "Physical Culture and Sports"*. [document on the Internet]. Accepted by Academic Board of Lviv State University of Physical Culture. 2016. [cited 2021 Jan 12]. Available from: https://www.ldufk.edu.ua/files/Navchal'na%20robota/Akredytacia/osv.%20progr.%20fizk.%20bakf.pdf (in Ukrainian)
18. *Regulations on organization and conduct of current and final control and mechanism of appealing against the results of students*. [document on the Internet]. Accepted by Academic Board of Lviv State University of Physical Culture. 2019. [cited 2021 Jan 12]. [cited 2021 Jan 12]. Available from: https://www.ldufk.edu.ua/files/tekst_fail/dokumenty%20LDUFK/oskarzhennja%20rezultativ%20navchannja%2004%2020.pdf (in Ukrainian)
19. *Provisions on scholarship support for students, postgraduates, doctoral students*. [document on the Internet]. Accepted by Academic Board of Lviv State University of Physical Culture. [cited 2021 Jan 12]. Available from: https://www.ldufk.edu.ua/files/Nauka/Studentska%20nauka/polozhennia%20kinc.pdf (in Ukrainian)
20. Soper HE, Young AW, Cave BM, Lee A, Pearson K. On the distribution of the correlation coefficient in small samples. Appendix II to the papers of "Student" and R. A. Fisher. A co-operative study. *Biometrika*, 1917; 11 (4): 328–413. https://doi.org/10.1093/biomet/11.4.328
21. Bonett DG, Wright TA. Sample size requirements for Pearson, Kendall, and Spearman correlations. *Psychometrika,* 2000; 65: 23–28. https://doi.org/10.1007/bf02294183
22. Walsh JE. Bounded Probability Properties of Kolmogorov–Smirnov and Similar Statistics for Discrete Data. *Annals of the Institute of Statistical Mathematics,* 1963; 15 (1): 153–158. https://doi.org/10.1007/bf02865912
23. *Social Science Statistics*. [document on the Internet]. [cited 2021 Jan 12]. Available from: https://www.socscistatistics.com/
24. *Excel help & learning*. [document on the Internet]. [cited 2021 Jan 12]. Available from: https://support.microsoft.com/en-us/excel
25. Zanevskyy I, Zanevska L. Models of intra- and interclass correlation test mean-score reliability. *Journal of Testing and Evaluation,* 2017; 45 (6): 1853–1861. https://doi.org/10.1520/JTE20140363
26. Aghdasi MT, Nasiri M. Motivations and to notify its relationship with socioeconomic conditions of male and female participants in public exercises in the city of Tabriz. *World Applied Sciences Journal,* 2012;17 (1): 109-112.
27. Chan YK, Chen S, Tu KW, Chi LK. Effect of autonomy support on self-determined motivation in elementary physical education. *J. Sport Sci. Med*. 2016; 15: 460–466.
28. Arias-Estero JL, Castejon FJ, Yuste JL. Psychometric properties of the intention to be physically active scale in primary education. *Rev. Educ*. 2013; 362: 485–505. https://doi.org/10.4438/1988-592X-RE-2013-362-239
29. Gillison FB, Rouse P, Standage M, Sebire SJ, Ryan RM. A meta-analysis of techniques to promote motivation for health behaviour change from a Self-Determination Theory perspective. *Health Psychol. Rev*. 2019; 13: 110–130. https://doi.org/10.1080/17437199.2018.1534071

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ORIGINAL ARTICLE

Effects of 8-week zumba exercise on blood lipids profile in sedentary women

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: Different aerobic exercise may affect women's health behaviours. Therefore, this study aimed to determine the effect of 8-week Zumba exercises applied to sedentary women on lipid profile.

Material: Fifty voluntary healthy sedentary women with a mean age of 32.1 ± 6.8 years and a mean height of 158.4 ± 15.5 cm participated in the study. Before and after the exercise program, blood samples and body weight were taken on before breakfast in the morning by experts in the appropriate laboratory environment, some environmental measurements. In the analysis of the data, the SPSS 22.0 package program was used to compare the pre-post exercise values (Paired Sample T-Test) as well as descriptive statistics. The effect sizes (Cohen's d) were calculated to provide the estimation of the comparisons between the pre-test and post-test results of the obtained values.

Results: According to the results, it was determined that there were significant differences between blood lipids Glucose, Urea, Triglyceride, total High-Density Lipoprotein Cholesterol (HDL-C) and Low-Density Lipoprotein Cholesterol (LDL-C) levels before and after Zumba exercise program ($p < 0.05$). In addition, it was determined that there was a significant and positive change between the pre-test and post-test BMI values ($p < 0.05$).

Conclusions: According to the results of the study, it was concluded that the 8-week Zumba exercise program applied to sedentary women had a positive effect on the lipid profiles of women.

Keywords: zumba, aerobic exercise, blood lipids, physical activity, health

Introduction

Technological development will continue causing inactivity in modern life. Negative effects in inactivity associated with physiological and psychological disorders such as obesity, diabetes, cardiovascular diseases, stress, depression [1-3]. For this reason, people need to recover physically and mental health. According to the World Health Organization, physically active women percentage are decreasing to men in high and low-income countries [4]. It's known that physical activity provides positive effects on psychological and physical health [5, 6]. Therefore, new exercise approaches could be a trigger to women for a more active life.

Many health problems in women such as insulin resistance, total and abdominal visceral fat and intramuscular fat increasing with age [7, 8]. Whereas many researchers determined to many benefits of aerobic exercises improving well-being, cardiovascular, aerobic fitness and lipid profile in women [9, 10]. Despite many benefits of physical active life, people get hard to maintain to exercise in daily routine. Fjeldsoe et al. [11] some factors could be a reason to layover physical activity. Thus, different types of aerobic exercise may be more efficient to maintain exercise and increasing motivation. In the long-term effect exercise on physiological responses can be determined to enjoyment participation. For this reason, Vendramin et al. [12] state that most people will be participating like Zumba, Pilates and Spinning exercise. During the last few years, Zumba is one of the new trends in fitness however has plenty of participants in the world [13]. Zumba includes the basics of salsa, samba, cumbia and the basic aerobic steps of other Latin American dances, but also enriches its content with other dances such as hip-hop, belly dance [14-16]. Previous research showed that people who participate in Zumba exercises increasing to enjoyment and motivation [17, 18]. Besides, Zumba exercises have many positive physiological effects such as body weight, blood lipid levels, some diameter and circumference measurements, providing hormonal balance, and preventing cardiovascular diseases [19]. Sustained more working time with inactive effect on some physical and physiological health, especially in women compared to men in life [20]. In this context, although it's all known that both aerobic and Zumba exercises effect some anthropometric (body mass index, body fat percentage, body weight) and blood lipid profile [10, 12]. There is no study. In the literature how effects on Zumba exercise blood lipid profile in sedentary women. We hypothesized that the Zumba exercise would be beneficial effects on blood lipid profile in sedentary women for a healthy life.

Materials and Method

Participants

The study was carried out in accordance with the pre-test post-test model. 50 voluntary healthy sedentary

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women with a mean age of 32.1 ± 6.8 years and a mean height of 158.4 ± 15.5 cm included in the study. Two measurements were taken in the study as pre and post-test. No diet program was applied to the participants. By asking whether the participants have serious illnesses that may affect physical activity and working, the participants who had were not included in the study. The pre-tests of all participants were taken before starting the study, and the post-tests were taken at the end of 8 weeks. During the study, all participants were asked to continue their normal life and not to do extra physical activity during the exercise protocol.

Anthropometric Measurements

Weight, percentage of fat, and body mass index (BMI) were measured using a bio-impedance-meter scale TANITA BC 532 (Tokyo, Japan). All measurements before breakfast in the morning taken by experts in a suitable environment.

Biochemical Analysis

Blood samples collected before first exercise and at the end of last exercise, determined health institution on before breakfast in the morning by laboratory environment. Blood values; Glucose, Urea, Aspartate Aminotransferase AST, Alanine Aminotransferase (ALT), Triglyceride, Total Cholesterol LDL-C and HDL-C values were obtained by making complete blood counts measurements in Backman Coulter auto analyser.

Exercise Program

Zumba Fitness Exercise (ZFE) programme lasted 3 days per week in 8 weeks. The Zumba Fitness program was led by a professional Zumba instructor. The Zumba Fitness program took into account the choreographies and class structure of the official Zumba ZIN DVD. Each exercise session starts warm-up of 5-10 minutes including a combination of one or two Latin dance pieces and dynamic stretching. Then women exercised with Zumba figures at 50-60% of the target heart rate of 60 minutes 6 to 8 tracks in the main section with a combination of different Latin rhythms. (40 to 45 minutes) occurred. Dynamic stretching and breathing techniques for 5 to 10 minutes were used with slow music to calm down [14, 20].

Statistical Analysis

Descriptive statistics (mean, standard deviation) and paired sample t-test statistical techniques were used in the analysis of the data. The effect sizes (Cohen's d) were calculated in order to estimate the comparisons between pre-test and post-test results. Thresholds for effect size statistics are as follows: <0.20 = not important, 0.20–0.59 = small, 0.6–1.19 = medium, 1.2–1.99 = large; ≥2.0 = very large [21]. The level of significance was set at 0.05 and the analyses were carried out on the Windows SPSS 22 program.

Results

As shown in Table 1, the mean scores of experimental groups are nearly the same, indicating equality of group regarding their knowledge of targeted structures.

The mean age of the sedentary women in the study group was 32.1 ± 6.9, the mean of height was 158.4 ± 15.5, the mean of weight was 86.9 ± 15.6, and the mean of was 33.2 ± 6.3.

When Table 2 was examined, it was found that the applied Zumba exercise program caused significant changes in the weight and fat percentage values of the participants (p <0.05).

When Table 3 was examined; It was determined that there was a positive significant difference between the pre-test and post-test values in the blood lipid levels (triglyceride, total cholesterol, HDL-C and LDL-C), Glucose and Urea values of the participants. As can be understood from the results of the analysis, it can be said that the Zumba exercise program applied had a positive effect on the post-test results by decreasing the current values according to the pre-test results of the participants.

Table 1. Physiological characteristics of participants

Variables	x̄±SD
Age *(year)*	32.1±6,9
Weight *(kg)*	86.9±15.6
Height (*cm)*	158.4±15.5
BMI *(kg / m²)*	33.2±6.3

Table 2. Changes in Weight, BMI before and after 8-weeks Zumba exercise program

Variables	Pre	Post	p	Cohen *d*	Magnitude
	x̄±SD	x̄±SD			
Weight	86.9±15.6	82.9±15.5	**0.000****	0.25	Small
Percentage of fat	41.0±5.6	34.5±5.7	**0.000****	1.15	Large
BMI	33.6±6.3	32.3±6.2	**0.000****	0.20	Small

p<0.05**

Table 3. Changes in blood lipid before and after 8-weeks Zumba exercise program

Variables	Pre	Post	p	Cohen *d*	Magnitude
	x̄±SD	x̄±SD			
Glucose $_{(Mg/dL)}$	108.7±21.8	91.3±10.1	**0.00***	1.03	Large
Urea	25.3±8.0	18.6±4.9	**0.00***	1.00	Large
Triglyceride $_{(Mg/dL)}$	135.3±63.1	81.9±24.2	**0.00***	1.12	Large
Total Cholesterol $_{(Mg/dL)}$	198.3±46.4	146.5±28.2	**0.00***	1.09	Large
HDL-C$_{(Mg/dL)}$	42.7±10.3	57.8±12.4	**0.00***	-1.32	Large
LDL-C$_{(Mg/dL)}$	129.6±37.2	84.9±23.9	**0.00***	1.43	Large

p<0.05*

Discussion

The aim of the study is to examine the blood lipid effects of 8-week Zumba exercises on sedentary women. The results of the study showed that aerobic-based Zumba exercises showed significant differences in lipid blood profiles of sedentary women. There have been studies examining the effect of Zumba exercises on weight, body mass index and waist circumference [22-24], VO_{2max} [25, 26], and neuromuscular functions [27]. To our knowledge, there were not many studies investigating that Zumba exercises had an effect on blood lipid profiles in sedentary women.

It was known that aerobic exercises had a positive effect on weight loss and body mass index, body anthropometric parameters, and cardiovascular disorders and blood lipid profiles [28-30]. In studies examining the effect of aerobic exercises in middle age women, similar to the current study, aerobic-based exercises were effective in decreasing weight and body mass index [31-33]. When the results of this study were examined, it was seen that Zumba exercises caused a significant decrease in glucose level. Previous research also indicated that aerobic exercises reduced blood glucose levels [34-36]. Other studies showing that aerobic exercises reduce glucose levels were found in the literature, but most of these had done on diabetes Type I and II patients. [37-40]. There were some differences between the studies that examine the relationship between Zumba and glucose in the literature. In their study on 13 women aged 52.5 ± 10.6 years Araneta and Tanori [41], and Cugusi et al., [22] in their study on 27 sedentary women aged 38.9 ± 9.7 years stated that there was no difference between Zumba and glucose. In another study, it was stated that 15 of 30 sedentary female participants with a mean age (45.9 ± 9.6) actively participated in Zumba exercises for 40 weeks, while there was not attending, no difference in glucose amount after exercise was found [26]. Krishnan et al., [23] stated that Zumba exercises did not reveal a difference in glucose level in 14 healthy women and 14 diabetes type 2 patients with an average age (49.3 ± 12.1). It can be thought that the difference between the current study and the other studies was due to both the excess in the age range and the different sample groups. In the current study, urea levels also appeared to decrease significantly after the exercise. Huang et al., [42] stated that acute exercise may increase the intensity of urine removal from the body after exercise, however, in previous studies [43, 44], the urea level decreased after exercise. In this study, it can be said that the decrease in urea level may be normal because the urea value was taken after 24 hours.

When the effect of aerobic exercises on the blood lipid profile of sedentary women was examined, it was observed that sedentary women reduced their blood lipid profiles such as cholesterol, triglyceride, HDL-C and LDL-C [32, 34, 44, 45, 46].

In the current study, women who exercised Zumba showed a decrease in triglyceride, cholesterol and LDL-C levels and an increase in HDL-C levels. Krishnan et al., [23] stated that as a result of the 16-week Zumba exercises they applied to women with 14 diabetes and 14 without diabetes, Triglyceride levels decreased in women without diabetes. Similarly, Araneta and Tanori [41] stated that 12-week Zumba exercises decreased Triglyceride and HDL-C levels in women, but not significantly. It was seen in the literature that different exercises had a positive effect on the blood lipid profile of women. Luo and Zheng [47] stated that there was an increase in HDL-C values and a decrease in LDL-C, Triglyceride and total cholesterol levels in 12-week aerobic exercise combined with yoga to 81 female college students. Lee and Kim [48] observed that 16-week yoga exercises increased HDL-C, total cholesterol and triglyceride levels and decreased LDL-C levels in the blood lipid profile of 8 obese women. It posed a serious and fatal risk such as coronary artery disease in people who were physically inactive, and it was emphasized that this disease was associated with high blood lipid and lipoprotein levels [49]. In addition, in studies conducted, blood lipids and lipoproteins appear to be not only the cause of coronary artery diseases but also the cause of many diseases [30, 50] . Considering that aerobic exercises play an effective role in blood lipids and lipoproteins, it can be said that Zumba exercises can also be used as a different type of aerobic exercise.

Conclusion

The results of this study showed that 8-week Zumba exercises caused changes in weight, BMI and blood lipid profiles of sedentary women. In addition, like other aerobic exercises, Zumba exercises were effective in decreasing body composition and anthropometric characteristics of sedentary women. Considering the importance of the effects of features such as body composition on women in their daily lives, Zumba exercises can be used as a different method compared to classical methods. Another important result of the research was the altering effect of Zumba exercises on blood lipid profiles. It can be said that Zumba exercises were not only affecting body composition in sedentary women but also an important indicator for women to be healthy individuals. In addition, considering that Zumba exercises were a group exercise and music performed with certain rhythms, psychological effects on group dynamics will further increase the quality of the exercise and its effect on women. In future studies, it can be said that the examination of different physiological (such as Hearth Rate, Lactate level) psychological and effects will provide a different benefit to the literature.

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Conflict of interest

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References

1. *DHHS Physical Activity Guidelines Advisory Committee Report*. Washington, DC: US Department of Health and Human Services, edited by Services DoHaH; 2008.
2. Laaksonen DE, Lindstrom J, Lakka TA, Eriksson JG, Niskanen L, Wikstrom K, et al. Physical Activity in the Prevention of Type 2 Diabetes: The Finnish Diabetes Prevention Study. *Diabetes*, 2005;54:158–65. https://doi.org/10.2337/diabetes.54.1.158
3. Shiroma EJ, Lee I-M. Physical Activity and Cardiovascular Health: Lessons Learned From Epidemiological Studies Across Age, Gender, and Race/Ethnicity. *Circulation*, 2010;122:743–52. https://doi.org/10.1161/CIRCULATIONAHA.109.914721
4. World Health Organization. *Physical Activity and Women Fact-Sheet*. Available online: https://www.who.int/dietphysicalactivity/factsheet_women/en/ (accessed on 2 November 2019).
5. Baruth M, Wilcox S, Wegley S, Buchner DM, Ory MG, Phillips A, et al. Changes in Physical Functioning in the Active Living Every Day Program of the Active for Life Initiative®. *IntJ Behav Med,* 2011;18:199–208. https://doi.org/10.1007/s12529-010-9108-7
6. Murrock CJ, Graor CH. Effects of dance on depression, physical function, and disability in underserved adults. *J Aging Phys Act*. 2014;22(3):380–385. https://doi.org/10.1123/japa.2013-0003
7. Ryan AS, Nicklas BJ. Age-related changes in fat deposition in mid-thigh muscle in women: relationships with metabolic cardiovascular disease risk factors. *Int J Obes Relat Metab Disord*. 1999; 23:126 – 32. https://doi.org/10.1038/sj.ijo.0800777
8. Goodpaster BH, Thaete FL, Simoneau JA, Kelley DE. Subcutaneous abdominal fat and thigh muscle composition predict insulin sensitivity independently of visceral fat. *Diabetes*, 1997; 46:1579–85.
9. Donath L, Roth R, Hohn Y, Zahner L, Faude O. The effects of Zumba training on cardiovascular and neuromuscular function in female college students. *EurJSportSci*. 2014;14(6):569–577. https://doi.org/10.1080/17461391.2013.866168
10. Arslan E, Can S, Demirkan E. Effect of short-term aerobic and combined training program on body composition, lipids profile and psychological health in premenopausal women. *Science & Sports*. 2017:32(2): 106–113. https://doi.org/10.1016/j.scispo.2016.11.004
11. Fjeldsoe B, Neuhaus M, Winkler E, Eakin E. Systematic review of maintenance of behavior change following physical activity and dietary interventions. *Health Psychol.* 2011;30(1):99–109. https://doi.org/10.1037/a0021974
12. Vendramin B, Bergamin M, Gobbo S, Cugusi L, Duregon F, Bullo V, et al. Health Benefits of Zumba Fitness Training: A Systematic Review. *PM&R*, 2016;8:1181–200. https://doi.org/10.1016/j.pmrj.2016.06.010
13. Brenscheidt gen. Jost D. "A Mover la Colita": Zumba Dance-Fitness in Mexico and Beyond. In: de Casanova EM, Jafar A, editors. *Bodies Without Borders,* New York: Palgrave Macmillan US; 2013. P. 143–61. https://doi.org/10.1057/9781137365385_10
14. Bayraktar A, Kılınç H, Kayantaş İ, Günay M. The effect of 12-week regular Zumba exercises on antropometric properties. *Journal of Human Sciences*, 2020; 17(1): 154– 161. https://doi.org/10.14687/jhs.v17i1.5913
15. Ljubojević A, Jakovljević V, Popržen M. Effects of Zumba fitness program on body composition of women. *SportLogia*, 2014; 10(1): 29–33. https://doi.org/10.5550/sgia.141001.en.004L
16. Assunção Júnior JC, Almeida Silva HJ, Silva JFC, Silva Cruz R, Almeida Lins CA, Souza MC. Zumba dancing can improve the pain and functional capacity in women with fibromyalgia. *J Body w Mov Ther.* 2018;22(2):455–459. https://doi.org/10.1016/j.jbmt.2017.09.022
17. Bennett P, Corradini A, Ockerby C, Cossich T. Exercise during hemodialysis the intradialytic Zumba Gold. *Nephrol News Issues*, 2012; 26:31–32.
18. Krishnan S, Tokar TN, Boylan MM, Griffin K, Feng D, Mcmurry L, et al. Zumba® Dance Improves Health in Overweight/Obese or Type 2 Diabetic Women. *Am J Hlth Behav*, 2015;39:109–20. https://doi.org/10.5993/AJHB.39.1.12
19. Oge B. *A research on the effects of an 8-week zumba and step-aerobics exercise on serum leptin and serum ghrelin hormones in women.* [Unpublished Master's Thesis]. Van.; 2019.
20. Barranco-Ruiz Y, Ramírez-Vélez R, Martínez-Amat A,

Villa-González E. Effect of Two Choreographed Fitness Group-Workouts on the Body Composition, Cardiovascular and Metabolic Health of Sedentary Female Workers. *Int J Environ Res Public Health*. 2019;16(24):4986. https://doi.org/10.3390/ijerph16244986

21. Hopkins WG, Marshall SW, Batterham AM, Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sport Exerc*. 2009; 41(1):3– 12. https://doi.org/10.1249/MSS.0b013e31818cb278
22. Cugusi L, Wilson B, Serpe R, et al. Cardiovascular effects, body composition, quality of life and pain after a Zumba fitness program in Italian overweight women. J *Sports Med Phys Fitness*, 2016; 56(3):328–335.
23. Krishnan S, Tokar TN, Boylan MM, Griffin K, Feng D, Mcmurry L, et al. Zumba® Dance Improves Health in Overweight/Obese or Type 2 Diabetic Women. *Am J Hlth Behav*, 2015;39:109–20. https://doi.org/10.5993/AJHB.39.1.12
24. Micallef C. The effectiveness of an 8-week Zumba programme for weight reduction in a group of Maltese over weight and obese women. *Sport Sci Health*, 2014; 10: 211–217. https://doi.org/10.1007/s11332-014-0195-8
25. Rossmeissl A, Lenk S, Hanssen H, Donath L, Schmidt-Trucksäss A, Schäfer J. Zum Beat: Evaluation of a Zumba Dance Intervention in Post-menopausal Overweight Women. *Sports (Basel)*, 2016;4(1):5. https://doi.org/10.3390/sports4010005
26. Barene S, Krustrup P, Brekke OL, Holtermann A. Soccer and Zumba as health-promoting activities among female hospital employees: a 40-weeks cluster randomized intervention study. *J Sports Sci*. 2014;32(16):1539–1549. https://doi.org/10.1080/02640414.2014.906043
27. Donath L, Roth R, Hohn Y, Zahner L, Faude O. The effects of Zumba training on cardiovascular and neuromuscular function in female college students. *Eur J Sport Sci*. 2014;14(6):569–577. https://doi.org/10.1080/17461391.2013.866168
28. Dianatinasab A, Koroni R, Bahramian M, Bagheri-Hosseinabadi Z, Vaismoradi M, Fararouei M, et al. The effects of aerobic, resistance, and combined exercises on the plasma irisin levels, HOMA-IR, and lipid profiles in women with metabolic syndrome: A randomized controlled trial. *Journal of Exercise Science & Fitness*, 2020;18:168–76. https://doi.org/10.1016/j.jesf.2020.06.004
29. Roffi M, Patrono C, Collet J-P, Mueller C, Valgimigli M, Andreotti F, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). *Eur Heart J*, 2016;37:267–315. https://doi.org/10.1093/eurheartj/ehv320
30. Church T. Exercise in obesity, metabolic syndrome and diabetes. *Prog Cardiovasc Dis,* 2011;53(6): 412–4188. https://doi.org/10.1016/j.pcad.2011.03.013
31. Pedersen BK, Saltin B. Evidence for prescribing exercise as therapy in chronic disease. *Scand J Med Sci Sports,* 2006;16 (Suppl 1):3–63. https://doi.org/10.1111/j.1600-0838.2006.00520.x
32. Rossi FE, Fortaleza AC, Neves LM, Buonani C, Picolo MR, Diniz TA, et al. Combined training (aerobic plus strength) potentiates a reduction in body fat but demonstrates no difference on the lipid profile in post-menopausal women when compared with aerobic training with a similar training load. *J Strength Cond Res*, 2016;30: 226–234. https://doi.org/10.1519/JSC.0000000000001020
33. Mendonça RMSC, Júnior Araujo AT, Sousa MSC, Fernandes HM. The effects of different exercise programme son female body composition. *J Hum Kinet*, 2014;43(1): 67–78. https://doi.org/10.2478/hukin-2014-0091
34. Mohr M, Lindenskov A, Holm PM, Nielsen HP, Mortensen J, Weihe P, et al. Football training improves cardiovascular health profile in sedentary, premenopausal hypertensive women. *Scand J Med Sci Sports*, 2014;24: 36–42. https://doi.org/10.1111/sms.12278
35. MacDonald TL, Pattamaprapanont P, Pathak P, Fernandez N, Freitas EC, Hafida S, et al. Hyperglycaemia is associated with impaired muscle signalling and aerobic adaptation to exercise. *Nat Metab*, 2020;2:902–17. https://doi.org/10.1038/s42255-020-0240-7
36. Karolkiewicz J, Michalak E, Pospieszna B, Deskur-Śmielecka E, Nowak A, Pilaczyńska-Szcześniak, Ł. Response of oxidative stress markers and antioxidant parameters to an 8-week aerobic physical activity program in healthy, post-menopausal women. *Archives of Gerontology and Geriatrics*, 2009; 49(1): e67–e71. https://doi.org/10.1016/j.archger.2008.09.001
37. Sideravičiūtė S, Gailiūnienė A, Visagurskienė K, Vizbaraitė D. The Effect of Aerobic Exercises on Blood Glucose Concentration in Healthy Girls and Girls with Type 1 Diabetes Mellitus. *Baltic Journal of Sport and Health Sciences*, 2018;4. https://doi.org/10.33607/bjshs.v4i63.578
38. Tan S, Du P, Zhao W, Pang J, Wang J. Exercise Training at Maximal Fat Oxidation Intensity for Older Women with Type 2 Diabetes. *Int J Sports Med*. 2018;39(5):374–381. https://doi.org/10.1055/a-0573-1509
39. Dincer S, Altan M, Terzioglu D, et al. Effects of a regular exercise program on biochemical parameters of type 2 diabetes mellitus patients. *J Sports Med Phys Fitness*, 2016;56(11):1384–1391.
40. Mitranun W, Deerochanawong C, Tanaka H, Suksom D. Continuousvs interval training on glycemic control and macro- and micro vascularre activity in type 2 diabetic patients. *Scand J Med Sci Sports*, 2014;24(2):e69–e76. https://doi.org/10.1111/sms.12112
41. Araneta MR, Tanori D. Benefits of Zumba Fitness® among sedentary adults with components of the metabolic syndrome: a pilot study. *J Sports Med Phys Fitness*, 2015;55(10):1227–1233.
42. Huang M, Lv A, Wang J, Zhang B, Xu N, Zhai Z, et al. The effect of intradialytic combined exercise on hemodialysis efficiency in end-stage renal disease patients: a randomized-controlled trial. *Int Urol Nephrol*, 2020;52:969–76. https://doi.org/10.1007/s11255-020-02459-1
43. Tangvarasittichai S, Lertsinthai P, Taechasubamorn P, Veerapun O, Tang varasittichai O. Effect of moderate-intensity exercise training on body weight, serum uricacid, serum hs-CRP, and insulin sensitivity in type 2 diabetic patients. *Siriraj Medical Journal,* 2017; 61(6), 310–313.
44. Sokal P, Jastrzębski Z, Jaskulska E, Sokal K, Jastrzębska M, Radzimiński Ł, et al. Differences in Blood Urea and Creatinine Concentrations in Earthed and Unearthed Subjects during Cycling Exercise and Recovery. *Evidence-Based Complementary and Alternative Medicine*, 2013;2013:1–6. https://doi.org/10.1155/2013/382643
45. Hallage T, Krause MP, Haile L, Miculis CP, Nagle EF, Reis RS, et al. The effects of 12 weeks of step aerobics training on functional fitness of elderly women. *J Strength Cond Res*, 2010;24(8): 2261–2266. https://doi.org/10.1519/JSC.0b013e3181ddacc6
46. Kerksick C, Thomas A, Campbell B, Taylor L, Wilborn C, Mar-cello B, et al. Effects of a popular exercise and weight loss

program on weight loss, body composition, energy expenditure and health in obese women. *NutrMetab*, 2009; 6(1): 231–17. https://doi.org/10.1186/1743-7075-6-23

47. Luo J, Zheng B. Effect of yoga combined with aerobic exercise intervention on morphological and blood lipid indicators in female college students. *J Sports Med Phys Fitness*, 2020;60(3):442–448. https://doi.org/10.23736/S0022-4707.19.10147-8
48. Lee J-A, Kim J-W, Kim D-Y. Effects of yoga exercise on serum adiponectin and metabolic syndrome factors in obese postmenopausal women: Menopause: *The Journal of The North American Menopause Society*, 2012;19:296–301. https://doi.org/10.1097/gme.0b013e31822d59a2
49. Gordon B, Chen S, Durstine JL. The effects of exercise training on the traditional lipid profile and beyond. *Curr Sports Med Rep.* 2014;13(4):253–259. https://doi.org/10.1249/JSR.0000000000000073
50. Vickers KC, Remaley AT. HDL and cholesterol: life after the divorce?. *J Lipid Res.* 2014;55 (1):4–12. https://doi.org/10.1194/jlr.R035964

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ORIGINAL ARTICLE

Playing traditional games vs. free-play during physical education lesson to improve physical activity: a comparison study

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Abstract

Purpose: Non-sport activities like traditional games can be a practical way to promote physical activity (PA) during physical education (PE) lessons, especially among those who are less inclined towards sports. The purpose of this study is to compare the PA variables and acceptance between playing traditional games and free-play during physical education lessons among secondary school students.

Material: Fifty-six (n = 56) subjects participated in this study wore accelerometers for a total of 40 minutes during each PE lesson to record PA. In the first week, a 40-min free-play PE lesson was done while in the second week, a 40-min PE lesson incorporated with traditional games (TG-PE lesson) was done. After following both lessons, subjects filled up a questionnaire on acceptance of TG-PE and free-play PE lessons.

Results: The mean total activity count ($p < 0.05$) and time spent in moderate-to-vigorous physical activity (MVPA) ($p < 0.05$) were 20% and 19% greater respectively during TG-PE lesson compared to free-play PE lesson. The mean acceptance scores showed students preferred playing TG (19.29 ± 4.21; $p < 0.00$) over free-play PE lesson (17.59 ± 3.13).

Conclusions: In conclusion, incorporating fun and meaningful activities such as TG during PE lessons can serve as an alternative strategy to promote PA during school hours. Further studies are warranted to determine other types of TG that may promote PA among secondary school students.

Keywords: adolescents, exercise, physical activity, physical education, traditional games

Introduction

Physical activity (PA) is an essential contributing factor to children's and adolescents' well-being [1]. However, according to the Active Healthy Kids Global Alliance report from 49 countries, children around the world were not getting enough PAs, consequent to urbanisation and technological advancement [2]. The Malaysian School-Based Nutrition Survey (MSNS) reported that 50% of Malaysian school children aged 10 to 17 years were physically inactive, with girls being less active compared to boys [3]. In 2017, Institute of Public Health, Malaysia reported only 20% of secondary school children met the PA recommendations for children and adolescents (60 minutes of moderate-to-vigorous physical activity [MVPA]) [4]. The lack of activities has major implications for the health of children, and may be responsible for the rising paediatric obesity pandemic. Reducing physical inactivity would certainly reduce the risk of non-communicable diseases during childhood, as well as when they reach adulthood [5].

Physical education (PE) lessons in school provides an excellent avenue for children and adolescents to be physically active during school hours [6]. A high-quality PE curriculum enables all students to enjoy different types of PA, apart from having many positive benefits to physical and mental health such as improving cardiorespiratory fitness and body composition [7], increasing cognitive and academic performance [8, 9], and reducing mental stress among school children [10]. A study by Chen, Kim [11] indicated that school children who had greater frequency of participation in PE lessons were more likely to spend greater time in MVPA, even after school hours. Silva, Chaput [12] reported that an average of two times per week of PE lessons is needed to achieve an overall improvement on PA. PE is a compulsory subject taught in Malaysian primary and secondary schools and is divided into two parts: physical education (taught outside classroom) and health education (assigned topics taught in classroom) [13]. However, PE has become a less-favoured subject in recent years and is often viewed as a marginal subject within the curriculum, especially among secondary school students [14, 15]. Apart from a well-designed PE curriculum, the effectiveness of PE lesson delivery relies heavily on the teacher's competency and enthusiasm to motivate students to participate in PAs [16]. It is common to find non-specialised teachers teaching PE in schools and this contributes significantly to the PE quality [17]. Rustam and Kassim [18] reported a high incidence of lack of observation and supervision of PE lessons by school administrators in Malaysian schools, leading to inconsistencies as to how PE lessons are conducted across many schools [13]. Apart from the personnel factor, some studies reported that other factors impeding students' participation in PE lessons are lack of sports equipment and facilities [19-21].

Perhaps the most sustainable and quickest approach to promote PA during PE lessons among school children is to incorporate fun and meaningful activities [22] that

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will appeal to not only sports-inclined students, but also those who regard themselves as 'less sporty' [23]. One example is playing traditional games. Traditional games (TG) are simple in design and implementation, suitable in all weather conditions with low cost, space, time, and equipment, but still capable of promoting PA, comparable to playing organised sports [24, 25]. Enjoyment factor in TG can be an excellent way to motivate less physically active students to be active during PE lessons, something which organised sports cannot do [26]. Malaysia is a country rich with cultural heritage, especially TG. Among the various types of TG played in Malaysia are *Gasing* (Spintop), *Batu Seremban* (Five Stones), *Teng-Teng* (Hopscotch), *Polis Sentri* (Police and Thief), *Baling Selipar* (Throwing Slipper), *Galah Panjang* (Long Pole), and *Konda Kondi* (Catch the Stick) [27]. TG in Malaysia were formerly popular and played by people from a wide range of age and race. However, its popularity has dwindled over the last few decades and is less played by today's younger generation [28]. UNESCO encourages promotion of TG in order to foster cultural identities and respect for communities from different cultural background [25, 29].

Re-introducing TG into PE lessons would not only encourage the younger generation to appreciate Malaysian heritage and culture, but also be an alternative strategy to promote PA and health-related fitness among school children [25]. A recent intervention study in Iran demonstrated a positive effect of PE and TG in reducing overweight problem among secondary school girls [30]. Other studies reported that playing TG improves motor-related fitness such as agility, speed, and balance among primary and secondary school students [28, 31]. However, the levels of MVPA engaged while playing games were not assessed in previous studies, especially among secondary school children. Furthermore, it is not currently known whether playing TG during PE lessons would lead to a higher PA level compared to free-play, unstructured PE lessons normally taught in schools.

Despite the benefits of TG in terms of health and fitness, its acceptance among children and adolescents is still obscure. There are so many reasons why playing TG is being overlooked. One of the reasons is the emergence of technological gadgets. Today, children and adolescents prefer to stay inside the house and play with their gadgets, instead of playing outside [32]. Due to safety reasons, parents also discourage their children to play outside in the neighbourhood [33]. A study in the Philippines reported that half of the children feel safer playing computer games instead of playing physically outside their house [34]. In terms of the excitement of playing TG, a previous study reported that 78% of adolescents in Pakistan were not interested in playing traditional games [35]. Mohd Yusoff [36] explained that today's younger generation feel playing TG is boring, outdated, and unsuitable with modern times. In addition, most of the previous studies done on primary school students only showed an increase of self-efficacy level after playing TG [26, 37, 38]. Their acceptance level after playing TG, such as enjoyment, satisfaction, suitability, and future participation was not shown. No published data was confirmed regarding acceptance towards playing TG among secondary school students.

We hypothesised higher PA variables towards active TG during a PE lesson than a free-play PE lesson among secondary school students. We also hypothesised that active TG during a PE lesson will yield high acceptance score than a free-play PE lesson among secondary school students. The primary aim of this study is to determine and compare PA variables of playing TG and free-play during PE lessons. The secondary aim is to determine and compare acceptance scores between playing TG during a PE lesson and a free-play PE lesson among secondary school students. Further attention was focused on the difference of PA levels and acceptance scores between genders.

Material and Methods

Participants.

A list of secondary schools in Kuala Lumpur was obtained from the Kuala Lumpur Federal Territory Education Department. Purposive sampling method was adopted to select a secondary school from the list. The inclusion criteria for the school were co-ed Malaysian secondary school. While inclusion criteria for the student were aged between 13 and 14 or studying in the Form 1 and Form 2 classes. Finally, one secondary school from the Keramat district was chosen for the study. Subjects were excluded if they had chronic medical conditions or physical disabilities that would limit movement. The minimum sample size was calculated with GPower software [39] based on a previous study by Wilson, Evans [40] where the minimum sample was 36 subject.

Research Design

This study design was a cross-sectional study. Approval to conduct the study was obtained from the National University of Malaysia Research Ethics Committee (UKM1.21.3/ 244/ NN-2018-130) and the Ministry of Education (KPM.600-3/2/3-eras(1151)). Subjects were briefed about the study and informed that they have the right to refuse to participate if they wish to do so. Parental informed consent and student consent were obtained prior to data collection.

Subjects underwent anthropometric measurements prior to the study. Height and weight were measured using a SECA portable stadiometer 213 (SECA, German) and a digital weighing scale Model 803 (SECA, German), respectively. Body mass index (BMI) was calculated and the categories were determined according to z-score for BMI-for-age as previously set by WHO [41]. Waist circumference was measured using Lufkin W606PM (Lufkin, USA), while Omron Body Fat Analyser HBF-306 (Omron, Japan) was used to measure students' body fat percentage. Waist circumference was used to classify abdominal obesity based on Poh, Jannah [42].

The study was conducted in two PE lessons across two weeks. In the first week, subjects followed a free-play 40-min PE lesson, during which subjects had the freedom to carry out their preferred PA under a PE teacher's supervision. In the second week, subjects followed a 40-min PE lesson integrated with traditional games (TG-PE lesson). Due to the limitation of school compound, subjects played TG in the school hall. Each game was played for 20 minutes in multiple groups. All activities during TG-PE lesson were monitored by the researchers and PE teacher. Upon completion of both PE periods, subjects were asked to fill out a questionnaire on acceptance of playing TG and PE lesson activities.

Two traditional games (TG) were selected for this study, *Galah Panjang* (Long Pole) and *Baling Selipar* (Throwing Slipper). The selection of the games was based on the intensity and involvement of running activity [28]. *Galah Panjang* is a game which involves two teams, where one team is required to run past several parallel lines, guarded by the opposing team, without being touched or tagged by the opposing team [43]. *Baling Selipar* also involves two teams, the 'attack' and 'defend' teams. It is a strategic game, revolving around the mechanism of 'build-destroy-rebuild a pyramid'. The defending team is required to build a pyramid on the ground, using three rubber slippers. The attacking team's mission is to knock down the pyramid by throwing a slipper. The defending team needs to prevent the attacking team from rebuilding the pyramid arrangement by flinging a slipper to oust the attacking team [25].

PA was measured using Actigraph GT3X+ (Pensacola, Florida, USA). Subjects were instructed to wear the accelerometer attached to an elasticised belt around the waist, positioned just above the right hip during PE lessons. The data was downloaded using Actilife software version 6.13.2. The levels of PA were evaluated as total activity count, time spent in MVPA based on Freedson cut-off point [44], time spent in sedentary activity, and step count.

A simple questionnaire of acceptance of playing TG and PE lesson activities was developed based on Wasowicz [45] and Zeng, Hipscher [46]. The questionnaire has five items on TG and five items on PE lesson activities, where the questions consist of enjoyment (2 items), satisfaction (2 items), suitability of activities (4 items), and future participation (2 items). A five-point Likert scale was used to represent the score, i.e., 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). The scores of the questionnaire range from 5 to 25. A higher score indicates better acceptance towards playing TG and doing PE lesson activities. This questionnaire was pre-tested among a pilot sample of secondary school students for clarity, understanding, and language of each item before administering it into the study. The internal consistency of the questionnaire was 0.70.

Statistical Analysis

IBM SPSS Statistics version 23 software was used to analyse all the data. Descriptive analysis (frequencies, percentages, means ± standard deviations) was used to report demographic, anthropometric, PA data, and acceptance score on TG-PE and free-play PE lessons. Paired t-test was used to compare (1) PA variables during the TG-PE lesson and free-play PE lesson and (2) acceptance scores between TG and PE lesson activities. Independent t-test was used to test the difference of PA variables and acceptance scores between genders. P value of less than 0.05 was considered statistically significant.

Results

Demographic Data

A total of 56 students from Form 1 (n = 27) and Form 2 (n = 29) were involved in this study. Subjects' mean age was 13.5 ± 0.5 years. Most of the students were boys (57%; n = 32) and the rest were girls (43%; n = 24). The majority race of the subjects were Malays (96%; n = 54), followed by Chinese (2%; n = 1), and others (2%; n = 1).

Anthropometric Data

Table 1 shows anthropometric and body composition data of subjects. Subjects' weight, height, waist

Table 1. Subject's anthropometric and Body Composition [Mean ± SD/ % (n)]

Parameters	Overall (n=56)	Boys (n=32)	Girls (n=24)
Weight (kg)	53.9 ± 16.4	57.7 ± 18.8	48.9 ± 11.2
Height (cm)	155.9 ± 8.9	159.4 ± 9.3	151.1 ± 5.5
Waist circumference (cm)	68.1 ± 13.1	72.3 ± 13.9	62.6 ± 10.0
BMI (kg/m^2)	21.8 ± 4.9	22.2 ± 5.3	21.3 ± 4.4
BMI-for-age (z-score)	0.6 ± 1.6	0.7 ± 1.7	0.4 ± 1.3
Body fat percentage (%)	25.0 ± 6.6	23.2 ± 6.2	27.4 ± 6.4
BMI-for-age (z-score) categories[a]			
- Normal (< 2 SD)	52 (29)	44 (14)	62 (15)
- Overweight (2 – 3 SD)	21 (15)	22 (7)	21 (5)
- Obese (> 3 SD)	27 (15)	34 (11)	17 (4)
Waist circumference categories[b]			
- Not risk abdominal obesity (< 90 percentiles)	92 (47)	78 (25)	92 (22)
- Abdominal obesity (≥ 90 percentiles)	8 (9)	22 (7)	8 (2)

[a] WHO 2017 [41]; [b] Poh et al. 2011 [42]

circumference, BMI-for-age z-score, and body fat percentage were 53.9 ± 16.4 kg, 155.9 ± 8.9 cm, 68.1 ± 13.2 cm, 0.6 ± 1.6, and 25.0 ± 6.6% respectively. Half of the subjects were categorised within normal BMI (52%) whilst the rest were overweight (21%) and obese (27%). There were more obese boys (34%) compared to obese girls (17%). Only 8% of the subjects fell into abdominal obesity category.

Overall Physical Activity Data

Table 2 shows the comparison of PA variables between free-play and TG-PE lessons. Total activity count showed a significant 20% increase during TG-PE lesson (113832 ± 32075) compared to free-play PE lesson (90662 ± 55042; p = 0.007). Time spent in MVPA during TG-PE lesson (28.9 ± 6.3 min) was 19% higher than in free-play PE lesson (23.5 ± 12.8 min; p = 0.006). Time spent in sedentary activity was reduced to as much as 45% during TG-PE lesson (5.3 ± 4.3 min) compared to free-play PE lesson (10.7 ± 11.7 min; p = 0.003). Step count was 23% higher during TG-PE lesson (1379 ± 455) than in free-play PE lesson (1066 ± 890; p = 0.010).

Comparison of Physical Activity between Genders

Table 3 shows the gender comparison for PA variables between free-play and TG-PE lessons. Boys recorded a significantly higher step count (1287 ± 1023 steps) compared to girls (772 ± 570 steps; p = 0.031) during the free-play PE lesson. However, there were no significant differences for the time spent in sedentary, time spent in MVPA, and total activity count between boys and girls during the same lesson. On the other hand, total activity count (boys: 126585 ± 30966; girls: 96829 ± 25293; p = 0.000), time spent in MVPA (boys: 30.9 ± 5.6 min; girls: 26.2 ± 6.2 min; p = 0.004), and step count (boys: 1563 ± 472 steps; girls: 1134 ± 290 steps; p = 0.000) were significantly greater in boys compared to girls during TG-PE lesson.

Within the boys' group, the total activity count (21%; p = 0.018) and time spent in MVPA (19%; p = 0.012) showed significant increases. While time spent in sedentary decreased significantly (-48%; p = 0.021) during TG-PE lesson compared to free-play PE lesson. Within the girls' group, the time spent in sedentary decreased significantly (-52%; p = 0.041) while the step count showed a significant increase (32%; p = 0.006) during TG-PE lesson compared to free-play PE lesson.

Comparison of Acceptance Score towards PE Lessons

Table 4 shows the comparison of overall and by domain acceptance scores towards playing TG-PE lesson and free-play PE lesson. Overall, subjects recorded higher acceptance scores for TG-PE lesson (19.29 ± 4.21)

Table 2. Comparison of Physical Activity Variables between Free-Play PE Lesson and TG-PE Lesson (Mean ± SD)

PA Variables	Free-play PE Lesson	TG-PE Lesson	p value
Total activity counts	90662 ± 55042	113832 ± 32075*	0.007
Time spent in MVPA (minutes)	23.5 ± 12.8	28.9 ± 6.3*	0.006
Time spent in sedentary (minutes)	10.7 ± 11.7	5.3 ± 4.3*	0.003
Step count	1066 ± 890	1379 ± 455*	0.010

*significant difference between free-play PE lesson and TG-PE lesson

Table 3. Gender Comparison for Physical Activity Variables between Free-Play PE Lesson and TG-PE Lesson (Mean ± SD)

PA Variables	Free-play PE Lesson	TG-PE Lesson
Total activity counts		
Boys (n=32)	99666 ± 54587	126585 ± 30966[a,b]
Girls (n=24)	78657 ± 54456	96829 ± 25293
Time spent in MVPA (minutes)		
Boys (n=32)	25.0 ± 11.5	30.9 ± 5.6[a,b]
Girls (n=24)	21.5 ± 14.2	26.2 ± 6.2
Time spent in sedentary (minutes)		
Boys (n=32)	8.4 ± 9.1	4.4 ± 3.7[b]
Girls (n=24)	13.7 ± 14.1	6.6 ± 4.8[b]
Step count		
Boys (n=32)	1287 ± 1023[a]	1563 ± 472[a]
Girls (n=24)	772 ± 570	1134 ± 290[b]

[a] significant comparison between gender within the same PE lesson; [b] significant comparison between PE lessons within the same gender

compared to free-play PE lesson (17.59 ± 3.13; p = 0.009). Domain of enjoyment scores for TG-PE lesson (4.0 ± 1.0) were significantly higher than free-play PE lesson (3.8 ± 1.1; p = 0.033). Scores for domain of satisfaction for TG-PE lesson (7.6 ± 1.9) were significantly higher than free-play PE lesson (7.0 ± 1.5; p = 0.002). Meanwhile, for suitability and future participation domains, no difference was noted between TG-PE and free-play PE lessons.

Comparison of Acceptance Score towards PE Lessons across Gender

Table 5 shows the comparison of acceptance scores towards free-play PE lesson and TG-PE lesson across gender. Overall acceptance scores for TG-PE lesson were higher (boys: 18.66 ± 4.78; girls: 20.13 ± 3.22) compared to free-play PE lesson (boys: 17.00 ± 3.17; girls: 18.38 ± 2.95) in both genders but were not statistically significant (p = 0.089). Within the girls' group, acceptance scores towards TG-PE (20.1 ± 3.2) were significantly higher than free-play PE lesson (18.4 ± 3.0; p = 0.036).

For the acceptance scores based on domains across gender, only satisfaction in TG-PE lesson showed a significantly higher score (8.1 ± 1.5) than free-play PE lesson (7.3 ± 1.3; p = 0.010) within girls' group. Meanwhile, other domains did not show any difference between TG-PE lesson and free-play PE lesson either within or across gender.

Discussion

The primary aim of this study is to compare PA levels between PE lesson incorporated with TG (TG-PE) and free-play PE lesson. Overall, our study demonstrated that playing TG led to significant increase in total activity count, step count, and time spent in MVPA. As well as reduced time spent in sedentary activity compared to free-play PE lesson. These findings indicated that playing TG during PE lesson is more effective at promoting PA compared to free-play PE activities. One of the main issues of declining participation during PE lessons in Malaysian secondary schools is that PE is becoming less enjoyable due to more challenging games or sports being taught. This may not appeal to students who are less

Table 4. Comparison of Acceptance Score towards Free-Play PE lesson and TG-PE Lesson (Mean ± SD)

Score	Free-Play PE Lesson	TG-PE Lesson	p value
Overall	17.6 ± 3.1	19.3 ± 4.2*	0.009
By domain			
- Enjoyment	3.8 ± 1.1	4.0 ± 1.0*	0.033
- Satisfaction	7.0 ± 1.5	7.6 ± 1.9*	0.002
- Suitability	3.4 ± 1.3	3.9 ± 1.2	0.059
- Future participation	3.4 ± 1.0	3.7 ± 1.1	0.263

*Significant difference (p<0.05) of score between PE lesson

Table 5. Comparison of Acceptance Score towards Free-Play PE Lesson and TG-PE Lesson across Gender (Mean ± SD)

Score	Free-Play PE Lesson	TG-PE Lesson
Overall		
Boys (n=32)	17.0 ± 3.2	18.7 ± 4.78
Girls (n=24)	18.4 ± 3.0	20.1 ± 3.2[a]
By domain		
- Enjoyment		
Boys (n=32)	3.8 ± 1.2	4.0 ± 1.1
Girls (n=24)	3.8 ± 1.0	4.1 ± 0.9
- Satisfaction		
Boys (n=32)	6.8 ± 1.6	7.3 ± 2.1
Girls (n=24)	7.3 ± 1.3	8.1 ± 1.5[b]
- Suitability		
Boys (n=32)	3.2 ± 1.3	3.8 ± 1.4
Girls (n=24)	3.8 ± 1.3	4.0 ± 0.9
- Future participation		
Boys (n=32)	3.3 ± 1.1	3.7 ± 1.3
Girls (n=24)	3.5 ± 0.9	3.8 ± 0.9

[a] Significant difference (p<0.05) of overall score between PE lesson within same gender; [b] Significant difference (p<0.05) of domain score between PE lesson within same gender

sporty, who normally represent more than half of a class population [47]. The purpose of playing TG is more on promoting enjoyment rather than competition [48].

Our findings also demonstrated that playing TG does not only increase PAs in general, but also MVPAs. It is recommended that students engage in MVPA for at least 50% of the time they spend in PE class, one of the most critical outcome measures in determining the quality of a PE program [49], consistent with the evidence pointing to the association of MVPA with physical fitness and mental health [50]. The mean time spent in MVPA in the TG-PE lesson was 56% of the lesson time, indicating that TG can be a strategy to achieve MVPA of at least 50% of the lesson time. Fairclough and Stratton [51] had demonstrated that team games promote the highest levels of MVPA compared to individual activities and games. This could be explained in that team games are perceived to be fun and cooperative, and students can easily engage in PAs that require less specific skills, as in the case with TG [52]. In addition, the time spent in sedentary activity in this study was reduced to as much as 45% while playing TG compared to free-play PE lesson. In the current education systems, students spend about 97% of their time in school sitting in a traditional classroom setting [53]. Therefore, PE is considered as a predominant method to promote MVPA and reduce sedentariness during school hours [54]. In fact, Chen, Kim [11] in his study demonstrated the increase in daily MVPAs or sedentary behaviour respectively, highlighting the importance of PE in accumulating MVPAs in youth's daily lives.

As expected, this study observed that boys were generally 25% more active compared to girls, and boys also spent a greater proportion (18%) of lesson time involved in MVPA during TG-PE lesson compared to girls. This finding is consistent with many previous studies [55-57] that recognise gender differences with regards to PA participation. Boys are generally more concerned with sports and team-based activities, as well as possessing competitive streaks, while girls are more engaged in individual activities such as dance, gymnastics, and swimming [51, 58]. It is also apparent that the nature of the TG employed in this study required substantial amount of whole body movement of differing speeds, thus it is likely that the girls were less motivated than the boys to physically exert themselves. According to Telford, Telford [59], the gap of PA between gender could also be explained by girls being less favourably influenced by socio-ecological factors at individual, family, school, and environmental levels. Meanwhile, MVPA did not differ between TG-PE and free-play PE lessons, suggesting that playing TG may provide a boost for PA among school girls.

The secondary aim of this preliminary study is to determine and compare acceptance between PE lesson incorporated with TG (TG-PE) and free-play PE lesson. Our findings showed that TG-PE lesson was preferred over free-play PE lesson. It is possible that TG were accepted due to these activities being less strenuous, fun, and more enjoyable [24, 43]. Based on the acceptance by domains, subjects recorded higher enjoyment and satisfaction towards playing TG than free-play PE activities. The enjoyment and satisfaction levels increased due to the new activities being conducted during the PE lesson, which differed from the usual sports activities (e.g., football and badminton) [60]. Usual sports activities may be challenging and need more athletic skills which may not appeal to students who are less sports-oriented, i.e., half of class population [47]. McCarthy and Jones [61] also justified that there is no enjoyment when rules that are over-competitive, less socially-interactive, and less autonomous are enforced during sports activities.

Our findings also demonstrated that girls were satisfied towards playing TG over free-play PE activities compared to boys. Bronikowska, Petrovic [62] justified that girls enjoy traditional games due to those requiring less specific skills and less competition, while encouraging them to move at their own pace when playing. They also feel more enjoyable and conceive positive emotions when playing traditional games [48]. Compared to boys, girls are generally less concerned about sports activities that possess competitive streaks [51, 58]. Okely, Lubans [63] pointed out that adolescent girls are keener to play in a shorter duration, with frequent changes in the type of games, and prefer to play amongst them. Those reasons fit with this study protocol where the games were changed from one kind to another, played within 20 minutes, and played amongst girls only.

Playing TG is an excellent option in lieu of free-play PE lessons which are commonly practised in schools. When students are at liberty of carrying out their own PA, this can lead to issues such as students spending little effort during PE lessons [64], or avoiding participation altogether [65], especially when supervision is minimal. The strength of this present study shows incorporating TG during PE lessons requires minimal equipment and space than organised sports. As for the PE teachers, teaching TG during PE lessons can be convenient, requires less specific skills to teach, and relevant to incorporate into PE curriculum.

Limitations and Recommendations

However, this study has several limitations. We did not manage to determine the PA variables for each game separately. Although the types of TG (i.e. *Galah Panjang* [Long Pole] and *Baling Selipar* [Throwing Slipper]) chosen for this study were effective at increasing PAs during PE lesson. Therefore, we could not determine which traditional game was more advantageous than the other in regards to promoting MVPA, if such difference exists. This certainly highlights the need for such studies in the future. Second, the sample size for this study was relatively small due to time constraints. But we felt it is sufficient to provide the baseline information needed for planning future intervention involving TG in a bigger scale among school students. Third, even though the comparison of playing TG during PE lesson was made against free-play PE lesson, we only managed to conduct one session in both PE lessons due to time constraints. We suggested further investigation for longer duration to compare the acceptance scores between TG and PE lessons for a better picture.

Conclusion

Our findings showed that playing TG can increase PAs among secondary school students. Playing TG was preferred during PE lesson over free-play PE lesson especially among girls. This comparison study showed that incorporating fun and enjoyable activities such as TG during PE lessons can be an alternative in promoting PA during school hours. Future studies should expand into examining which other types of games that are more attractive and appealing to boost PAs in this particular group.

Highlights

Playing TG can an excellent option for improving PA levels during free-play PE lesson among secondary school students.

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References

1. Hills AP, Andersen LB, Byrne NM. Physical activity and obesity in children. *British Journal of Sports Medicine*. 2011;45(11):866–70. https://doi.org/10.1136/bjsports-2011-090199
2. Tremblay MS, Barnes JD, González SA, Katzmarzyk PT, Onywera VO, Reilly JJ, et al. Global Matrix 2.0: report card grades on the physical activity of children and youth comparing 38 countries. *Journal of Physical Activity and Health*. 2016;13(11 Suppl 2):S343–S66. https://doi.org/10.1123/jpah.2016-0594
3. Baharudin A, Zainuddin AA, Manickam MA, Ambak R, Ahmad MH, Naidu BM, et al. Factors associated with physical inactivity among school-going adolescents: data from the Malaysian School-Based Nutrition Survey 2012. *Asia Pacific Journal of Public Health*. 2014;26(5_suppl):27S–35S. https://doi.org/10.1177/1010539514543682
4. IKU. *National Health and Morbidity Survey 2017: Adolescent Nutrition Survey 2017*, Malaysia. Kuala Lumpur: Institut Kesihatan Umum, 2017. [cited 2020 June 23]. Available from: http://iku.moh.gov.my/nhms-2017
5. Lee WASS, Rengasamy S, Hooi LB. The level of intrinsic motivation among 13, 14 and 16 years old school students in physical education lessons. *Asian Journal of Physical Education and Computer Science in Sports*. 2015;12(1):116–121.
6. Johnson TG, Turner L. The physical activity movement and the definition of physical education. *Journal of Physical Education, Recreation & Dance*. 2016;87(4):8–10. https://doi.org/10.1080/07303084.2016.1142192
7. Ardoy DN, Fernández-Rodríguez J, Jiménez-Pavón D, Castillo R, Ruiz J, Ortega F. A Physical education trial improves adolescents' cognitive performance and academic achievement: the EDUFIT study. *Scandinavian Journal of Medicine & Science in Sports*. 2014;24(1):e52–e61. https://doi.org/10.1111/sms.12093
8. Telford RD, Cunningham RB, Fitzgerald R, Olive LS, Prosser L, Jiang X, et al. Physical education, obesity, and academic achievement: a 2-year longitudinal investigation of Australian elementary school children. *American Journal of Public Health*. 2012;102(2):368–74. https://doi.org/10.2105/AJPH.2011.300220
9. Rasberry CN, Lee SM, Robin L, Laris B, Russell LA, Coyle KK, et al. The association between school-based physical activity, including physical education, and academic performance: a systematic review of the literature. *Preventive Medicine*. 2011;52:S10–S20. https://doi.org/10.1016/j.ypmed.2011.01.027
10. Cowley J, Kiely J, Collins D. Is there a link between self-perceived stress and physical activity levels in Scottish adolescents? *International Journal of Adolescent Medicine and Health*. 2019;31:20160104. https://doi.org/10.1515/ijamh-2016-0104
11. Chen S, Kim Y, Gao Z. The contributing role of physical education in youth's daily physical activity and sedentary behavior. *BMC Public Health*. 2014;14(1):110. https://doi.org/10.1186/1471-2458-14-110
12. Silva DAS, Chaput J-P, Katzmarzyk PT, Fogelholm M, Hu G, Maher C, et al. Physical education classes, physical activity, and sedentary behavior in children. *Medicine & Science in Sports & Exercise*. 2018;50(5):995–1004. https://doi.org/10.1249/MSS.0000000000001524
13. Wee EH. Contemporary issues in the teaching of PE in Malaysia: *Proceedings of the 9th International Sports Science Conference 2012 June 25-28*; Kelantan, Malaysia: USM; 2013. P. 120–127.
14. Ismail WAW, Muhamad TA, Hubungan faktor penghalang terhadap penglibatan pelajar dalam Pendidikan Jasmani di sekolah menengah [The relationship of barriers to student involvemet in physical education in secondary schools]. *Proceedings of the 1st International Conference on Language, Education and Innovation 2015 Mar 16-17*; Kuala Lumpur, Malaysia: Infobase Creation; 2015. P. 123–130. (in Malay)
15. Kilue D, Muhamad TA. Cabaran pengajaran subjek pendidikan jasmani di sekolah menengah di Malaysia [Challenges in the teaching of physical education subject in Malaysian secondary schools]. *Journal of Nusantara Studies (JONUS)*. 2017;2(2):53–65. (In Malay) https://doi.org/10.24200/jonus.vol2iss2pp53-65
16. Husain MZ, Hasan A, Wahab NBA, Jantan J. Determining teaching effectiveness for physical education teacher. *Procedia-Social and Behavioral Sciences*. 2015;172:733–40. https://doi.org/10.1016/j.sbspro.2015.01.426
17. Morgan P, Bourke S. Non-specialist teachers' confidence to teach PE: the nature and influence of personal school experiences in PE. *Physical Education and Sport Pedagogy*. 2008;13(1):1–29. https://doi.org/10.1080/17408980701345550
18. Rustam S, Kassim M. The direction of physical and health education in 21st century in Malaysia. *Advances in Natural and Applied Sciences*. 2018 [cited 2020 July 29];12(4):11–6. Available from:http://www.aensiweb.net/AENSIWEB/anas/anas/2018/April/11-15(3).PDF
19. Zahidi M, Samad R. Influence of school environment in the teaching and learning of physical education. *Turkish Journal of Sport and Exercise*. 2014;16(2):70–6. https://doi.org/10.15314/tjse.79065
20. Ali SKS, Zahidi MA, Samad RSA, Wee A. Faktor kekangan ibu bapa dan persekitaran sekolah dalam pelaksanaan

pengajaran pendidikan jasmani di sekolah rendah [Parental constraints and school environment factors in the implementation of Physical Education in primary school]. *The Asia Pacific Journal of Curriculum and Teaching (JuKu)*. 2017 [cited 2020 June 23];2(2):1–15. (In Malay). Available from: https://juku.um.edu.my/article/view/8066
21. Abu Bakar NFS, Penglibatan pelajar dalam aktiviti pendidikan jasmani di sekolah menengah sekitar daerah Sentul, Kuala Lumpur [Student involvement in physical education activities in secondary schools around Sentul district, Kuala Lumpur], Kuala Lumpur. *Proceedings of the International Seminar in Education Issues (ISPEN 2018); 2018 5 July*; Selangor, Malaysia: KUIS; 2018. P. 45–51. (In Malay)
22. Burns RD, Fu Y, Podlog LW. School-based physical activity interventions and physical activity enjoyment: A meta-analysis. *Preventive medicine*. 2017;103:84–90. https://doi.org/10.1016/j.ypmed.2017.08.011
23. Visek AJ, Achrati SM, Mannix HM, McDonnell K, Harris BS, DiPietro L. The fun integration theory: toward sustaining children and adolescents sport participation. *Journal of Physical Activity and Health*. 2015;12(3):424–33. https://doi.org/10.1123/jpah.2013-0180
24. Tangkudung J, Aini K, Puspitorini W. Development of Physical Fitness Materials based on Traditional Games for Junior High School. *Proceedings of the 1st International Conference on Innovation in Education (ICoIE 2018),* Padang, Indonesia: Atlantis Press; 2019. https://doi.org/10.2991/icoie-18.2019.91
25. Zulkifli M, Putra A, Yusof M, Anuwar S, Norzaman NZA, Razali AF. Re-creation of Malaysian traditional game namely 'Baling Selipar': A Critical Review. *International Journal of Science, Environment and Technology*. [cited 2020 June 23] 2014;3(6):2084–9. Available from: http://www.ijset.net/journal/451.pdf
26. Louth S, Jamieson-Proctor R. Inclusion and engagement through traditional Indigenous games: enhancing physical self-efficacy. *International Journal of Inclusive Education*. 2018:1–15. https://doi.org/10.1080/13603116.2018.1444799
27. Rahman ISA. *Inventory of ASEAN Traditional Games and Sports*. Culture ACo, ASEAN Committee on Culture and Information; 1998.
28. Charles MAG, Abdullah MR, Musa RM, Kosni NA. The effectiveness of traditional games intervention program in the improvement of form one school-age children's motor skills related performance components. *Journal of Physical Education and Sport*. 2017;17:925–30. https://doi.org/10.7752/jpes.2017.s3141
29. Khan MZ, Abbas SG, Zeb R. The reasons for traditional games losing popularity: A case study of Skhy (Calf) in Nihagdara, KP (Pakistan). *THE SPARK A HEC Recognized Journal*. 2018 [cited 2020 Aug 23];3(1):100–11. Available from: http://journal.suit.edu.pk/index.php/spark/article/view/484/445
30. Ali SKS, Ranjbar Z. The effect of traditional games intervention on overweight among secondary school students in Iran. *Advanced Science Letters*. 2018;24(7):5434–7. https://doi.org/10.1166/asl.2018.11751
31. Abdullah B, Amri S, Yee KL, Samah BA. The impact of traditional games on the gross motor skill development of an early childhood. *The Social Sciences*. 2013;8(6):590–5. https://doi.org/10.3923/sscience.2013.590.595
32. Zahari ZA, Desa MAM, Bakhir NM. Permainan tradisional dan teknologi: Penelitian dan tinjauan terhadap persepsi kanak-kanak [Traditional games and technology: A review of children's perceptions]: *Proceedings of the 1st International Conference On Creative Media, Design & Technology (REKA2014)*; Penang, Malaysia: USM; 2014. P.67–72. (In Malay)
33. Valentine G, McKendrck J. Children's outdoor play: Exploring parental concerns about children's safety and the changing nature of childhood. *Geoforum*. 1997;28(2):219–35. https://doi.org/10.1016/S0016-7185(97)00010-9
34. Booc RP, Rafaela KB, Torres MJ, Bulawan RP, II LCJ, Cortuna IJM, Ascunsion JE. The traditional Filipino games: status check among generation z. *ISJ Theoretical & Applied Science*, 10 (78). 2019:150–2. https://doi.org/10.15863/TAS
35. Bashir J, Zain-Ul-Wahab BA. Polyhedron analysis of traditional games of Khyber Pakhtunkhwa, Pakistan. *WALIA Journal*. 2018 [cited 2020 July 29];32(1):5. Availbale from: http://waliaj.com/wp-content/2018/Issue%201,%202018/22w.pdf
36. Mohd Yusoff MY. Permainan tradisional masyarakat Melayu dalam kalangan generasi Z [Malay traditional games among generation Z]. *Proceeding of the 7th International Conference on Social Sciences and Humanities 2018 12-13 Nov*; Selangor, Malaysia: UKM; 2018. P. 123–131. (In Malay)
37. Trajkovik V, Malinovski T, Vasileva-Stojanovska T, Vasileva M. Traditional games in elementary school: Relationships of student's personality traits, motivation and experience with learning outcomes. *PloS One*. 2018;13(8):e0202172. https://doi.org/10.1371/journal.pone.0202172
38. Rothlein L, Einspruch E, Goldberg S. A study of traditional circle games played in public school kindergartens across the United States. *International Journal of Early Childhood*. 1988;20(2):55. https://doi.org/10.1007/BF03174563
39. Faul F, Erdfelder E, Lang A-G, Buchner A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*. 2007;39(2):175–91. https://doi.org/10.3758/BF03193146
40. Wilson DK, Evans AE, Williams J, Mixon G, Sirard JR, Pate R. A preliminary test of a student-centered intervention on increasing physical activity in underserved adolescents. *Annals of Behavioral Medicine*. 2005;30(2):119. https://doi.org/10.1207/s15324796abm3002_4
41. WHO. *Growth reference data for 5-19 years* [document on the Internet] WHO 2007 [cited 2017 31 Oct]. Available from:http://www.who.int/growthref/en/
42. Poh BK, Jannah AN, Chong LK, Ruzita AT, Ismail M, McCarthy D. Waist circumference percentile curves for Malaysian children and adolescents aged 6.0–16.9 years. *Pediatric Obesity*. 2011;6(3-4):229–35. https://doi.org/10.3109/17477166.2011.583658
43. Ahmad S, Zakaria S. *Permainan tradisional di Malaysia* [Traditional games in Malaysia]. Kuala Lumpur: Buku Must; 2008. (In Malay)
44. Freedson P, Pober D, Janz FK. Calibration of accelerometer output for children. *Med Sci Sports Exerc*. 2005;37:S523-S30. https://doi.org/10.1249/01.mss.0000185658.28284.ba
45. Wasowicz I. *Traditional Games Comenius Project 2010* [document on the Internet] Comenius Project 2010 [cited 2018 4 Feb]. Available from: http://www.traditionalgamesandtoys.com/page10.html&as_qdr=y15
46. Zeng HZ, Hipscher M, Leung RW. Attitudes of high school students toward physical education and their sport activity preferences. *Journal of Social Sciences*. 2011;7(4):529. https://doi.org/10.3844/jssp.2011.529.537

47. Owen MB, Curry WB, Kerner C, Newson L, Fairclough SJ. The effectiveness of school-based physical activity interventions for adolescent girls: A systematic review and meta-analysis. *Preventive Medicine*. 2017;105:237–49. https://doi.org/10.1016/j.ypmed.2017.09.018
48. Lavega P, Alonso JI, Etxebeste J, Lagardera F, March J. Relationship between traditional games and the intensity of emotions experienced by participants. *Research Quarterly for Exercise and Sport*. 2014;85(4):457–67. https://doi.org/10.1080/02701367.2014.961048
49. Hollis JL, Sutherland R, Williams AJ, Campbell E, Nathan N, Wolfenden L, et al. A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in secondary school physical education lessons. *International Journal of Behavioral Nutrition and Physical Activity*. 2017;14(1):52. https://doi.org/10.1186/s12966-017-0504-0
50. Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput J-P, Janssen I, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism*. 2016;41(6):S197–S239. https://doi.org/10.1139/apnm-2015-0663
51. Fairclough S, Stratton G. 'Physical education makes you fit and healthy'. Physical education's contribution to young people's physical activity levels. *Health Education Research*. 2004;20(1):14–23. https://doi.org/10.1093/her/cyg101
52. Zhou Y, Wang L. Correlates of physical activity of students in secondary school physical education: A systematic review of literature. *BioMed Research International. 2019*;2019. https://doi.org/10.1155/2019/4563484
53. Cardon G, De Clercq D, De Bourdeaudhuij I, Breithecker D. Sitting habits in elementary schoolchildren: a traditional versus a "Moving school". *Patient Education and Counseling*. 2004;54(2):133–42. https://doi.org/10.1016/S0738-3991(03)00215-5
54. Fairclough S, Stratton G. Physical activity levels in middle and high school physical education: a review. *Pediatric Exercise Science*. 2005;17(3):217–36. https://doi.org/10.1123/pes.17.3.217
55. Smith NJ, Lounsbery MA, McKenzie TL. Physical activity in high school physical education: impact of lesson context and class gender composition. *Journal of Physical Activity and Health*. 2014;11(1):127–35. https://doi.org/10.1123/jpah.2011-0334
56. Teo PS, Nurul-Fadhilah A, Aziz ME, Hills AP, Foo LH. Lifestyle practices and obesity in Malaysian adolescents. *International Journal of Environmental Research and Public Health*. 2014;11(6):5828–38. https://doi.org/10.3390/ijerph110605828
57. Cheah YK, Lim HK, Kee CC, Ghazali SM. Factors associated with participation in physical activity among adolescents in Malaysia. *International Journal of Adolescent Medicine and Health*. 2016;28(4):419–27. https://doi.org/10.1515/ijamh-2015-0030
58. Marques A, Ekelund U, Sardinha LB. Associations between organized sports participation and objectively measured physical activity, sedentary time and weight status in youth. *Journal of Science and Medicine in Sport*. 2016;19(2):154–7. https://doi.org/10.1016/j.jsams.2015.02.007
59. Telford RM, Telford RD, Olive LS, Cochrane T, Davey R. Why are girls less physically active than boys? Findings from the LOOK longitudinal study. *PloS One*. 2016;11(3):e0150041. https://doi.org/10.1371/journal.pone.0150041
60. Gao Z, Zhang P, Podlog LW. Examining elementary school children's level of enjoyment of traditional tag games vs. interactive dance games. *Psychology, Health & Medicine*. 2014;19(5):605–13. https://doi.org/10.1080/13548506.2013.845304
61. McCarthy PJ, Jones MV. A qualitative study of sport enjoyment in the sampling years. *The sport psychologist*. 2007;21(4):400–16. https://doi.org/10.1123/tsp.21.4.400
62. Bronikowska M, Petrovic L, Horvath R, Hazelton L, Ojaniemi A, Alexandre J, et al. History and cultural Context of Traditional Sports and Games in Selected European Countries. In: Bronikowska M, Laurent JF, editors. *Recall:Games of the Past-Sports for Today*.Poland:TAFISA; 2015.
63. Okely AD, Lubans DR, Morgan PJ, Cotton W, Peralta L, Miller J, et al. Promoting physical activity among adolescent girls: the girls in sport group randomized trial. *International Journal of Behavioral Nutrition and Physical Activity*. 2017;14(1):81. https://doi.org/10.1186/s12966-017-0535-6
64. Ntoumanis N, Pensgaard A-M, Martin C, Pipe K. An idiographic analysis of amotivation in compulsory school physical education. *Journal of Sport and Exercise Psychology*. 2004;26(2):197–214. https://doi.org/10.1123/jsep.26.2.197
65. Brooks F, Magnusson J. Taking part counts: adolescents' experiences of the transition from inactivity to active participation in school-based physical education. *Health Education Research*. 2006;21(6):872–83. https://doi.org/10.1093/her/cyl006

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ORIGINAL ARTICLE

The comparative analysis of morphological and functional indicators of armwrestling and street workout athletes

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Abstract

Background and Study Aim The purpose of the work is a comparative analysis of morphological and functional indicators and characteristics of the somatotype of armwrestling athletes and street workout athletes.

Material and Methods The study involved Street Workout athletes (StW, n = 15, age - 14.87 ± 0.42 years, training experience - 1.48 ± 0.22 years) and armwrestling athletes (ArW, n = 11, age - 14.87 ± 0.42 years, training experience - 1.48 ± 0.22 years). The body length and body mass were determined. The level and harmony of physical development were assessed by the regression method. Handgrip was assessed in a static mode. The electronic handgrip dynamometer Camry EH101 (China) was used. The handgrip is determined by the maximum frequency of the grip in 10 s. The electronic device "Kepai" (China) was used to measure it. The content of muscle and adipose tissue, the level of visceral fat were determined. The body structure monitor OMRON BF-511 (Japan) was used. The handgrip index, hand impulse index, static and dynamic handgrip index were calculated. Differences were assessed using the Rosenbaum test (Q).

Results A high level of handgrip was determined for all athletes. The average value of the strength index was the StW group - more than 60% of body mass; the ArW group - more than 70% of body mass. The following indicators were observed in the ArW group: harmonious physical development had (27.27 ± 13.43)% of athletes; disharmony due to excess body mass had (45.45 ± 15.01)% of athletes; disharmony due to body mass deficit had (27.27 ± 13.43)% of athletes; normal fat content had (63.64 ± 14.50)% of athletes; low-fat content had (18.18 ± 11.63)% of athletes; high and high-fat content had (9.09 ± 8.67)% of athletes. The ArW group was characterized by high - (50.00 ± 15.81)%, high - (40.00 ± 15.49)%, and normal - (10.00 ± 9.49)%-the specific weight of muscle tissue. In the StW group, the following indicators were observed: harmonious physical development had (46.67 ± 12.88)% of athletes; disharmony due to excess body mass had (53.33 ± 12.88)% of athletes; normal fat content had (57.14 ± 13.23)% of athletes; low-fat content had (42.86 ± 13.23)% of athletes. All athletes in the StW group had a high proportion of muscle tissue. It was found that exercises with your body mass in a street workout decreased fat content compared to armwrestling.

Conclusions: The results confirmed the specific effect of the sport on the body of athletes. Handgrip should be considered as a success predictor in these sports. The information content of the proposed handgrip indices for monitoring the functional state of athletes was confirmed.

Keywords: armwrestling, street workout, physical development, somatotype, bioimpedance method, handgrip.

Introduction

Martial arts and strength sports are traditionally the most popular among young people. Martial arts form the physical and psychological qualities of athletes; the worldview of youth [1]. The young generation has a growing need for an athletic and well-built body. Therefore, the number of people involved in various power sports (bodybuilding, powerlifting, arm wrestling), as well as the recently appeared street workout, is increasing. Mulyk et al. [2] investigated the popularity of fitness programs among students. The most popular are strength and Martial arts: Crossfit Training, Kickboxing, Tabata Training, Body Sculpt, Barbell Workout.

Improving one's command of his or her own body can dramatically improve movement quality, and performance [3]. Bodyweight exercises allow athletes to improve how they manipulate their bodies through space in a way that is both important for health and difficult to replicate with other training methods that do not always accommodate a client's unique anthropometry. The street workout is a unique sport in this context. This type of exercise is based on the use of your body mass and allows optimizing the muscle mass [4].

Taipe-Nasimba et al. [5] studied the psychosocial profile of Street Workout athletes. It was concluded that this sport is beneficial for enhancing physical activity. It improves opportunities for social inclusion. The advantages also include low economic cost and

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affordability for the population. The analysis of the main psychological characteristics of Street Workout athletes made it possible to determine the fact that this sport is dominated by men under the age of 23; the main motivation of men is taking care of their health and their appearance [6].

Determination of the morphological characteristics of the most popular sports allows assessing and comparing athletes. It is valuable for improving their results. Chernozub et al. [7] confirmed the positive influence of strength exercises on morphometric indicators and adaptive-compensatory capabilities of female athletes. The study of physical development peculiarities allows assessing the specificity of the influence of the kind of sport on the body of athletes [8]. The use of special indices allows highlighting the features and qualities that are predictors of success in different types of Martial arts.

Recently, there has been a growing interest in the analysis of the morphological status and body structure. Body shape and morphology are the main factors determining athletic performance [9]. Thus, the diagnosis of somatotype and anthropometric characteristics are often the subject of research for a certain population group [10]. Because of its uniqueness, the somatotype has been used to study many aspects of exercise, sports science, and human biology. It is important for identifying talented young athletes in specific sports [11].

The purpose of the research is a comparative analysis of anthropometric indicators and somatotype of workout and armwrestling athletes.

Material and Methods

Participants.

The study involved 26 street workout (StW) and armwrestling (ArW) athletes. The athletes were divided into two groups. The StW group included 15 Street Workout athletes (age 14.87 ± 0.42 years). The ArW group included 11 armwrestling athletes (age 18.50 ± 0.43 years). The average work experience was in the StW group - 1.48 ± 0.2 years; in the ArW group - 2.35 ± 0.33 years. Differences between the groups in age and training experience are significant ($p < 0.05$).

Research Design

The research design involved the determination of anthropometric indicators, somatotype components, and the calculation of indices using special formulas. The research program and design were discussed and approved at The Meeting of Bioethics Commission of Kharkiv State Academy of Physical Culture (record from 04/12/2021).

The calculation of body mass and body length was conducted according to international standards [12]. Martin's medical anthropometer was used to calculate body length (cm). Body composition monitor OMRON BF-511 (Japan) was used to calculate body mass (kg). The assessment of the harmony of physical development level was conducted by the regression method using official standards for children [13] and adults [14].

The handgrip (kg) was calculated in a static mode by dynamometry. CAMRY EH101 electronic hand dynamometer was used (China). The handgrip is determined by the maximum grip frequency in the impulse mode (abs). The electronic device "Kepai" (China) was used. The technique assumed the maximum number of device grip in 10 s. One grip was equivalent to a force of 10 kg.

The somatotype was assessed using the bioimpedance method. The body composition monitor OMRON BF-511 (Japan) was used. The specific weight of muscle and adipose tissue (%), the level of visceral fat (%), the amount of basal metabolism (kcal) were determined. The analysis of somatotype components was assessed according to the Omron Healthcare scale and the recommendations of Doskin et al. [15].

The following morphofunctional indices were calculated:

Strength index (%) - the ratio of handgrip indicators (kg) to body mass (kg).

Impulse index (%) - the ratio of the maximum frequency of the handgrip in impulse mode in 10 s (abs) to body mass (kg).

Static and dynamic grip index is the ratio of handgrip (kg) to the maximum frequency of the handgrip in impulse mode in 10 s (abs).

Statistical Analysis.

Statistical analysis was performed using licensed MS Excel. The following indicators are determined by descriptive statistics: arithmetic mean (M), standard deviation, and mean error (m). Due to the small number of groups, the reliability of the differences was assessed using a nonparametric indicator - the Rosenbaum criterion (Q); differences were considered significant at ($p < 0.05$).

Results

The results are shown in Table 1.

The results of the table illustrate the high level of handgrip strength in all participants: the average value of the strength index in the StW group was more than 60% of the body mass, and in the ArW group - more than 70% of the body mass.

Significant differences were found between the groups. The ArW group characterized by excess body length (Q = 8), handgrip of the right hand (Q = 7) and left hand (Q = 12), the level of visceral fat (Q = 10), strength index of the right (Q = 19) and left hand (Q = 26), impulse index of the right hand (Q = 13) and left hand (Q = 15), static and dynamic handgrip index of the right hand (Q = 12).

The physical development level in the ArW group was determined: average, high, and below-average had (27.27 ± 13.43)% of athletes; above-average had (18.18 ± 11.63)% of athletes. The following indicators were determined: (27.27 ± 13.43)% of athletes had harmonious physical development; disharmony due to excess body mass had (45.45 ± 15.01)% of athletes and due to a deficiency in body mass had (27.27 ± 13.43)% of athletes.

In the StW group, the average level of physical development was (53.33 ± 12.88)% of athletes, above the average - (20.00 ± 10.33)%, below the average and high

Table 1. Indicators of physical and somatotype development of armwrestling athletes and street workout athletes

Indices	StW (n=15)	ArW (n=11)
Body length, cm	170.53±2.70	180.60±2.21
Body mass, kg	64.58±3.95	74.00±4.39
Handgrip of right hand, kg	40.03±2.70	53.01±4.66
Handgrip of left hand, kg	38.52±2/37	52.00±4.01
Maximum grip frequency in pulse mode of the right hand, number of times	26.73±2.59	32.40±1.65
Maximum grip frequency in pulse mode of the left hand, number of times	23.93±2.92	28.60±2.01
The specific weight of adipose tissue,%	12.95±8.97	14.41±11.11
The specific weight of muscle tissue,%	41.81±13.18	43.01±15.66
The value of the main metabolism, kcal	1697.93±49.02	1734.00±65.09
The specific weight of visceral fat,%	0	4.11±6.28
Right hand strength index,%	63.25±12.89	72.59±13.45
Left hand strength index,%	60.63±13.06	70.91±13.69
Impulse index of the right hand, kg^{-1}	39.60±13.07	44.42±14.98
Impulse index of the left hand, kg^{-1}	36.04±12.83	38.96±14.70
Static and dynamic handgrip index of the right hand, kg	1.57±0.09	1.66±0.15
Static and dynamic handgrip index of the left hand, kg	1.68±0.11	1.89±0.19

level according to (13.33 ± 8.78)%. (46.67 ± 12.88)% of athletes had harmonious physical development. Disharmony due to excess body weight was observed in (53.33 ± 12.88)% of athletes.

The analysis of the somatotype characteristics according to the Omron Healthcare scale determined that in the StW group (57.14 ± 13.23)% of the athletes had a normal fat content, (42.86 ± 13.23)% of the athletes had a low-fat content. All athletes in this group had a high specific weight of muscle tissue. In the ArW group, the normal fat content had (63.64 ± 14.50)% of athletes, low fat content had (18.18 ± 11.63)% of athletes, high and high-fat content had (9.09 ± 8.67)% of athletes. Athletes in this group were characterized by high (50.00 ± 15.81)%, high (40.00 ± 15.49)%, and normal (10.00 ± 9.49)% specific weight of muscle tissue.

Basal metabolic results in the groups did not differ significantly.

Discussion

The study of the influence specificity of a kind of sport on the athletes' body is one of the important tasks of sports science. It allows optimizing the process of sports selection, to improve the effectiveness of the success' prediction and skills development in certain sports. Identification of success predictors can significantly improve the performance of athletes. Research results have confirmed the importance of many factors in this context. Chernenko et al. [16] confirmed the existence of a correlation between the typological characteristics of the nervous system and the high sports achievements of wrestlers. The authors recommended using functional mobility of the central nervous system as criteria for assessing the prospects of wrestlers.

Jagiello et al. [17] investigated the body structure of athletes of the Polish women's national fencing team. The specificity of the athletes' body structure engaged in saber fencing has been determined. It is concluded that there is a correlation with the long-term effects of training, as well as with the selection of athletes with specific somatic prerequisites.

The importance of studying the characteristics of athletes' body structure is confirmed in the works of Jagiello et al. [17–19]. The use of the Percala method of natural indicators made it possible to determine in the Martial arts athletes the most important functions for achieving success. The results allow optimizing the training process.

The studies based on comparing the characteristics of athletes in various sports are widespread. The choice of armwrestling and Street Workout for comparison is due to their strength orientation. Both sports require a strong handgrip to be successful. It predetermined the developed research program aimed at studying the strength of the hand muscles.

A similar research design was used in the study of Kharisov et al. [20, 21] The authors compared the anthropometric indicators and the somatotype composition of students in powerlifting and workout. Volodchenko et al. [22] conducted a comparative analysis of the psychophysiological status of athletes involved in various types of Martial arts. The highlighted features are interpreted from the standpoint of the athlete's skills development. Methods for their assessment are proposed to be used in monitoring the functional state of Martial art athletes.

A similar set of techniques was used in the study by Podrihalo et al. [23] Comparison of the results of armwrestlers with different skill levels confirmed the importance of developing hand muscles and body structure for achieving success in this sport. The parallel study of handgrip in static and dynamic modes is important in armwrestling. The success in this sport is determined by the strength and maximum speed of the handgrip.

Participants belong to different age groups. Athletes in the StW group are in puberty and prepubertal period, which is characterized by intensive development of the body. The ArW athletes are in a more stable condition. On the one hand, different periods cause differences in functional performance. Alternatively, the differences increase against the background of intense strength training. It is why indices were used. These indicators are relative values and allow for standardizing the factors under study.

The index method is widely used in sports science. The calculation and analysis of indices allow simply, quickly, and visually assess the features of the physical development and functional state of athletes. Currently, the indices are used in complex systems for assessing health and physical fitness. The informativeness of indices in armwrestling has been proven. The effectiveness of predicting the performance of athletes in this sport was confirmed using indices [24].

Methods for assessing muscle strength and body composition are used to assess the effectiveness of training in sports and recreational activities. Kalwa et al. [25] used a similar design to assess the performance of people over 40 years of age. Confirmed an increase in hand strength, a decrease in body mass and adipose tissue, an improvement in physical fitness and body mobility. Feito et al. [26] used similar techniques to analyze the adaptation to high-intensity training. Mandaric and Sibinovic [27] evaluated the effectiveness of workout training in water in terms of strength and body structure.

In our study, high values of the strength index of athletes reflect the importance of handgrip in both sports. In armwrestling, a strong and high-quality handgrip increases the likelihood of winning the fight. Podrihalo et al. [23] assessed this indicator as one of the success predictors. The results of Podrigalo et al. [24] confirmed the informativeness and significance of the strength index for assessing handgrip. Simultaneously, a handgrip in Street Workout is important for the technical performance of apparatus exercises. A high-quality handgrip serves not only to optimize the technique but also to prevent injuries in this sport.

However, one strength index is not enough to assess the handgrip. It led to the development of other indices given in this research. The impulse index is an indicator that we proposed by analogy with the strength index. It illustrates the handgrip in impulse mode relative to body mass. The results of Iermakov et al. [28] confirmed the informative value of the maximum handgrip frequency in an impulse mode for predicting success in martial arts. This technique was used to analyze the armwrestler state with different skill levels [23]. The use of the index in the form of a relative indicator allows to increase the visibility and information content of the results; use the results in monitoring the functional state of athletes.

We have proposed another indicator for analyzing the results - it is the index of the static and dynamic handgrip. In our opinion, this index reflects the potential ability of hand muscles to work in different modes - static and dynamic. The large value of this index among athletes of the ArW group is another proof of the importance of handgrip strength for success in this sport.

The study of the influence of morphological characteristics on success in sports allows to draw up specification equations for a particular sport and contribute to a more adequate modeling of athletes' actions [29].

The analysis of physical development is an effective tool for assessing the athletes' state. In the ArW group, athletes were almost equally divided according to average, high, and below-average levels of physical development. The group is dominated by participants with disharmonious physical development. Almost 50% of the disharmony was due to overweight. In the context of using the bioimpedance method, it reflects an increase in the specific weight of muscle tissue. It is a consequence of the intense strength training typical of armwrestling.

Deviations from the average physical development in athletes of the StW group were less expressed. Among them, athletes with an average level of development prevailed. In terms of harmony, the athletes were divided almost equally. Simultaneously, disharmony was due only because of excess body weight. It should also be assessed as an illustration of the increase in muscle tissue content.

The assumptions made earlier were confirmed by the results of the bioimpedance method. It can be argued that there is a tendency to exceed the number of athletes with normal fat content compared to athletes with low-fat content in the StW group. Simultaneously, all athletes in this group characterized by a high content of muscle tissue. In the ArW group, the distribution of athletes was more complicated. The vast majority of athletes had normal body fat content. The vast majority of armwrestlers (90%) had high levels of muscle tissue. Similar results are presented in the study by Kharisov et al. [20, 21] compared Street Workout athletes with powerlifters. Powerlifters are characterized by a more developed chest, a stronger body structure, and a larger biceps stroke. Workout athletes have a more developed ideal body structure compared to powerlifters. Powerlifting athletes are characterized by a significantly higher body mass index, body fat.

The results of the somatotype analysis illustrate the specificity of the influence of the sport on the athletes' bodies. Arm wrestling and street workout strength sports. It leads to intense strength training. This approach increases the specific weight of muscle tissue.

Results of Sanchez-Martinez et al. [30] confirmed that Street Workout athletes have a balanced mesomorphic somatotype; low-fat mass; high muscle development with a predominance of the shoulders and trunk. The value of the body composition indices allows such athletes to be classified as a low-risk group for chronic non-infectious diseases.

Street workout includes exercises with a body, and exercises with weights are common in armwrestling. In both cases, your body mass is a factor in achieving success. In armwrestling, increasing body mass allows developing more strength in a fight. In the street workout, reducing body mass allows exercising with less effort. It is precisely what the established features of the somatotype of athletes reflect.

The closeness of the results of the basal metabolic rate illustrates the similarity of the metabolic features of athletes, which are characteristic of power loads.

Conclusion

The comparative analysis of morphological and functional indicators and somatotype features of armwrestling and Street Workout athletes confirmed the specific influence of the sport on the athletes' organism. All athletes are characterized by an increased specific weight of muscle tissue. The information content of the proposed indices, characterizing the handgrip in the impulse mode, has been confirmed. It is recommended to use it in monitoring the functional state of athletes. The handgrip should be considered a success predictor of street workout and armwrestling. Indicators and indices of handgrip strength allow to adequately assess the athletes' state. The analysis of the athletes' physical development also confirms the specificity of the sport influence. Exercising with your body mass in the Street Workout decreased fat content compared to arm wrestling.

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Conflict of interests

The authors declare no conflict of interest.

References

1. Blach W, Korobeynikov G, Vences de Brito A, Warchol K, Cynarski WJ. Brief review of scientific events and publications –in the sphere of human and cultural problems, and martial arts discourse 2020. *Ido Movement for Culture Journal of Martial Arts Anthropology,* 2021;21:56–66. https://doi.org/10.14589/ido.21.1.8
2. Mulyk K, Maksimova K, Mulyk V. Motivational Principles of Using Various Fitness Programs. *Research Journal of Pharmaceutical Biological and Chemical Sciences.* 2018; 9(6): 673–680.
3. Langton B, King J. Utilizing body weight training with your personal training clients. *ACSMS Health & Fitness Journal.* 2018; 22(6): 44–51. https://doi.org/10.1249/FIT.0000000000000433
4. Dudziak T, Czubek Z, Grabowski M, Urbanski R, Sawczyn S. Changes in body composition of children aged of 9 to 12 years with excess body weight under the influence of eight-week workout. *Baltic Journal of Health and Physical Activity*, 2018;10:89–95. https://doi.org/10.29359/BJHPA.10.3.10
5. Taipe-Nasimba N, Peris-Delcampo D, Canton E. Motives for sports practice, psychological well-being and immigration in Street Workout practitioners. *Revista de Psicologia del Deporte*. 2019;28(2): 135–141.
6. Taipe-Nasimba N, Chirivella CE. Street Workout: Psychosocial Profile of its Practitioners. *Revista Internacional de Medicina y Ciencias de la Actividad Fisica y del Dep*orte. 2020; 20(79): 521–534. https://doi.org/10.15366/rimcafd2020.79.009
7. Chernozub A, Imas Y, Korobeynikov G. The influence of dance and power fitness loads on the body morphometric parameters and peculiarities of adaptive-compensatory reactions of organism of young women. *Journal of Physical Education and Sport*. 2018;18(2):955–960. https://doi.org/10.7752/jpes.2018.02141
8. Podrigalo L, Cynarski WJ, Rovnaya O, Volodchenko O, Halashko O, Volodchenko J. Studying of physical development features of elite athletes of combat sports by means of special indexes. *Ido Movement for Culture Journal of Martial Arts Anthropology*, 2019:51–7. https://doi.org/10.14589/ido.19.1.5
9. Matković, B. R., Mišigoj-Duraković, M., Matković, B., Janković, S., Ružić, L., Leko, G., Kondrič, M. Morphological Differences of Elite Croatian Soccer Players Accordning to the Team Position.Coll. *Antropol.* 2003;27(1): 167–174.
10. Joksimović M, Skrypchenko I, Yarymbash K, Fulurija D, Nasrolahi S, Pantović M. Anthropometric characteristics of professional football players in relation to the playing position and their significance for success in the game. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*, 2019;23(5):224–30. https://doi.org/10.15561/18189172.2019.0503
11. Carter JEL, Ackland TR, Kerr DA, Stapff AB. Somatotype and size of elite female basketball players. *Journal of Sport Sciences,* 2005;23(10): 1057–1063. https://doi.org/10.1080/02640410400023233
12. Marfell-Jones M, Olds T, Stewart A, Lindsay Carter LE. *ISAK manual, International standards for Anthropometric Assessment. In International Society for the Advancement of Kinanthropometry*. Published by The international society for the advancement of kinanthropometry, The University of South Australia Holbrooks Rd, Underdale, SA, Australia; 2012.
13. Serdiuk AM. *Standards for assessing the physical development of schoolchildren*. Kiev; 2010. (in Ukrainian).
14. Tegako LI, Marfina OV. *Practical anthropology*. Rostov on Don: Phoenix; 2003. (in Russian).
15. Doskin VA, Keller Kh, Muraenko NM, Tonkova-Yampolska RV. *Morphofunctional constants of the child's body*. Moscow: Medicine; 1997. (In Russian).
16. Chernenko N, Lyzohub V, Korobeynikov G, Potop V, Syvash I, Korobeynikova L, Kostuchenko V. Relation between typological characteristics of nervous system and high sport achieving of wrestlers. *Journal of Physical Education and Sport*, 2020;20(3):1621–1627. https://doi.org/10.7752/jpes.2020.03221
17. Jagiełło W, Marina J, Maciej KR, Jan BB, Artur L, Jarosław K. Properties of body composition of female representatives of the Polish national fencing team – the sabre event. *Biology of Sport.* 2017;34(4):401–406. https://doi.org/10.5114/biolsport.2017.70526
18. Jagiello W. Perkal's method of natural indicators in the assessment of internal proportions of body composition in persons practising combat sports - a review. *Archives of Budo*.2019; 15:187–193.
19. Jagiello W, Dornowski M, Jagiello M. Perkal's natural indicators method in assessing body composition properties in persons practising combat sports - an analysis research results. A*rchives of Budo Science of Martial Arts and Extreme Sports*. 2018;14:‏75–80.
20. Kharisov I, Nenasheva A. Physical fitness of students

practicing various artistic gymnastic routines. *Minerva Ortopedica e Traumatologic*. 2018; 69(3): 49–54.
21. Kharisov ID, Nenasheva AV, Aminov AS e.a. Assessment of physical fitness indicators in students practicing powerlifting and street workout. *Human Sport Medicine*. 2017; 17(1): 67–78. https://doi.org/10.14529/hsm170107
22. Volodchenko O, Podrigalo L, Aghyppo O. Comparative Analysis of a functional state of martial arts athletes. *Journal of Physical Education and Sport*. 2017;17(4SI):2142 –2147. https://doi.org/10.7752/jpes.2017.s4220
23. Podrihalo OO, Podrigalo LV, Bezkorovainyi DO, Halashko OI, Nikulin IN, Kadutskaya LA, et al. Analysis of grip strength and somatotype features of armwrestling athletes of different skill levels. *Physical Education of Students*. 2020;24(2):120–126. https://doi.org/10.15561/20755279.2020.0208
24. Rovnaya O, Podrigalo L, Iermakov S, Tetiana Yermakova, Vladimir Potop. The Application of the Index Method to Assess the Condition of Armwrestling Athletes with Different Levels of Sports Mastery. *Revista Romaneasca pentru Educatie Multidimensionala*. 2019;11(4SI):242–256. https://doi.org/10.18662/rrem/187
25. Kałwa M, Stefaniak T, Harmaciński D, Groffik B. A preparation cycle in strength training as a form of health training for adults. *Balt J Health Phys Act*, 2019; 11(1): 62–75. https://doi.org/10.29359/BJHPA.11.1.07
26. Feito Y, Hoffstetter W, Serafini P, Mangine G. Changes in body composition, bone metabolism, strength, and skill-specific performance resulting from 16-weeks of HIFT. *PLoS ONE*, 2018;13(6): e0198324. https://doi.org/10.1371/journal.pone.0198324
27. Mandaric S, Sibinovic A. Water Workout Application Effects on the Body Composition and Motor Abilities of 13-Year-Old Female Adolescents. International Journal of Morphology. 2018;36(2): 629–634. https://doi.org/10.4067/S0717-95022018000200629
28. Iermakov SS, Podrigalo LV, Jagiełło Wł. Hand-grip strength as an indicator for predicting the success in martial arts athletes. *Arch Budo*. 2016; 12: 179–186.
29. Gardašević N, Fulurija D, Joksimović M, Eler N, Ahmedov FS. The Influence of Morphological Characteristics on Throw Speed in Handball. *International Journal of Physical Education, Fitness and Sports*. 2020; 9(3): 32–38. https://doi.org/10.34256/ijpefs2035
30. Sanchez-Martinez J, Plaza P, Araneda A, Sánchez P, Almagiâ A. Morphological characteristics of Street Workout practitioners. *Nutricion Hospitalaria*. 2017;34(1): 122–127 https://doi.org/10.20960/nh.987

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ORIGINAL ARTICLE

Modeling: ratio between means of teaching and motor training in junior school physical education classes

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim The purpose of the study was to determine the ratio between means of teaching and motor training in junior school physical education classes.

Material and Methods The study involved 32 boys who were 8 years old at the beginning of the experiment. They were randomly divided into four groups of eight people each. A pedagogical experiment was conducted using a 2^2 full factorial design. The study recorded the following indicators: number of repetitions required to teach exercises; grade for a unidirectional movement coordination exercise (test 1); grade for a multidirectional movement coordination exercise (test 2); error in time accuracy of performing the squat thrust (test 3); error in time accuracy of 5 jumps on marks in 5 s (test 4); error in assessing muscular effort with visual control (test 5); vestibular stability, error (test 6). The obtained experimental material was processed statistically using statistical analysis software packages (SPSS 20).

Results According to the logistic function analysis, the achievement of an optimal result in differentiating temporal characteristics of movement requires 8.5 months, strength characteristics of movement – 8 months, movement coordination – 8 months, vestibular analyzer stability – 10 months. It takes 3 to 5 months to obtain positive increases in testing results in boys aged 8-9. The ratio of time allotted for strength training (ST) and coordination training (CT) to teaching motor actions (TMA) varies as 1:4 (ST: TMA) and 1:4.5 (CT: TMA).

Conclusions: The ratio of time allotted for strength training, coordination training, and teaching to the time of the main part of the class ranges between 14.3-23.5% (strength training), 17.1-23.5% (coordination training), and 53.0-68.6% (teaching). As exercises become more complicated, the time allotted for strength and coordination training increases.

Keywords: boys aged 8-9, logistic function, strength training, coordination training, teaching.

Introduction

In modern school, the physical education class is viewed as the main form of schoolchildren's motor activity [1-3]. The class aims to develop motor skills and motor abilities [4-6]. The process of teaching and motor abilities development in children and adolescents was studied in the following areas:

– motor training methodology [7-9];

– motor skills in the structure of schoolchildren's physical fitness [1, 10-12];

– gender-related peculiarities of motor skills development [13];

–factors influencing motor skills development [14-16];

– pedagogical control in the process of motor skills development [17-19];

– influence of motor skills development on improving the health of children and adolescents [20, 21].

It was found that the effectiveness of motor skills development is influenced both by the mode of exercises [22-24] and the content of teaching [25-27].

Studies of motor skills development used a factorial experiment to examine the structure of the educational process [28, 29], modeling [30, 31], the logistic function analysis to determine the duration of training and motor abilities development in children and adolescents [30, 31]. Researchers established the effectiveness of using the modeling method to obtain new information about the patterns of motor skills development.

However, there are few studies aimed at investigating the ratio between means of teaching and motor training in junior school physical education classes. Most studies focus on the structure of motor fitness [1, 10], modes of exercises during training [28].

Thus, the problem of determining the ratio between means of teaching and motor training in junior school physical education classes is relevant and requires further research.

The purpose of the study was to determine the ratio between means of teaching and motor training in junior school physical education classes.

Materials and methods

Participants

The study involved 32 boys who were 8 years old at the beginning of the experiment. They were randomly divided into four groups of eight people each. The children and their parents were informed about all the features of the study and gave their consent to participate

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in the experiment.

Research Design

A pedagogical experiment was conducted using a 2^2 full factorial design (Table 1). Strength and coordination training was carried out by means of basic gymnastics. The boys were taught the forward roll and the straddle vault over side vaulting buck. The study recorded the level of proficiency in the exercises p = m/n, where m is the number of successful attempts, n is the total number of attempts. For strength development, the combined method according to the first variant was used. Exercises at one place are performed in the following order: dynamic effort method, maximal effort method, isometric effort method, repeated effort method. For movement coordination development – repeated method, in the process of teaching – method of algorithmic instructions.

The study recorded the following indicators: number of repetitions required to teach exercises; grade for a unidirectional movement coordination exercise (test 1); grade for a multidirectional movement coordination exercise (test 2); error in time accuracy of performing the squat thrust (test 3); error in time accuracy of 5 jumps on marks in 5 s (test 4); error in assessing muscular effort with visual control (test 5); vestibular stability, error (test 6).

Testing methods

Test 1. Grade for a unidirectional movement coordination exercise, points.

Starting position (s.p.) – normal standing position (n.s.p.), 1 – step with the left leg, hands forward; 2. – s.p.; 3 – step with the right leg, hands up; 4 – s.p.

Test 2. Grade for a multidirectional movement coordination exercise, points.

S.p. – n.s.p. 1 – step with the left leg, right hand forward; 2 – s.p.; 3 – step with the right leg, hands up; 4 – s.p.

The tests were evaluated on the following scale: 10 points – mistake-free performance of the test; 9.5 points – one mistake was made (no coordination between arm and leg movements, one of the movements was forgotten); 9 points – two mistakes were made; 8.5 points – three mistakes were made.

General instructions and remarks. The teacher shows and performs the test once according to distribution, after which the students perform the test to the count for a grade.

Test 3. Error in time accuracy of performing the squat thrust 3 times in 3 s.

Test procedure. The test participant assumes the squat position. At the "Go" command, the participant begins to rhythmically perform the exercise.

Result. Time of performing the exercise. The error in time accuracy of performing the exercise is analyzed.

Test 4. Error in time accuracy of 5 jumps on marks in 5 s.

Test procedure. At the "Go" command, the test participant performs 5 jumps on marks, the distance between the marks is 50 cm.

Result. Time of performing the exercise. The error in time accuracy of performing the exercise is analyzed.

Test 5. Standing long jump at half strength, error in %.

This test was performed to assess muscular effort with visual control.

Equipment. Non-slip surface with a line and marking in centimeters.

Test procedure. The test participant toes the line, with a two foot take-off and arm swing jumps as far forward as possible, then repeats the jump at half strength.

Result. The distance of the maximum-effort jump and the distance of the jump at half strength were recorded in centimeters. The error in % was analyzed.

General instructions and remarks. The test is carried out in accordance with the rules for standing long jump competitions. Take-off and landing places must be at the same level.

Test 6. Walking in a straight line after three 360º turns, error cm.

This test was performed to assess vestibular stability.

Test procedure. After three turns of 360° each, stand with the back against the wall and walk 4 m in a straight line.

Result. Deviation from a straight line in centimeters.

Statistical analysis

To analyze the results, the algorithm from the studies by Khudolii et al. [29], Lopatiev et al. [30], Khudolii [31] was used.

1. The analysis of change in the results of strength and coordination fitness in the groups of factorial design showed that this process can be described using growth models:

Table 1. Matrix of the 2^2 factorial experiment in studying the influence of ratio variants of training means in the class on the level of strength, coordination fitness and proficiency in motor actions in boys aged 8-9 years

Group	N	Ratio variant of training means in the class	Strength training, min. X_1	Coordination training, min. X_2	Teaching motor actions, min.
Group 1	8	1	0	0	33
Group 2	8	2	12	0	21
Group 3	8	3	0	9	24
Group 4	8	4	12	9	12

$$Y = A/(1 + 10^{(a_m + bx)}) + C \quad (1)$$

where Y is the effectiveness of teaching motor actions, X is the number of training sessions held since the beginning of teaching the motor action, A is the distance between the upper (A–C) and lower (C) asymptotes, C is the lower asymptote, the point where the training begins; a, b are the parameters that determine the slope, bending, and inflection point of the logistic regression line.

2. The regression equation coefficients of the logistic function vary depending on the mode of training. Their change can be described by the following equation:

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_1x_2, \quad (2)$$

where Y is the effectiveness of training process; x_1 is the time allotted for strength training; x_2 – for coordination training.

3. The following formulas were used to determine an optimal result and time of its achievement:

$$Yopt.1 = Yo + 0.632 \times (A + C\text{-}Yo) \quad (3)$$

$$Zopt.up = 0.117 \times (A + C\text{-}Yo) \quad (4)$$

$$Ymax = Yopt.1 + 0.632 \times Zopt.up \quad (5)$$

where Yopt.1 is top optimum, Zopt.up is the zone of top optimum, Yo is the function's value at the point of inflection (am / b).

$$Yopt.2 = Yo + 0.368 \times (Yo\text{-}C) \quad (6)$$

$$Zopt.down = 0.117 \times (Yo\text{-}C) \quad (7)$$

$$Ymin = Yopt.2\text{-}0.368 \times Zopt.down \quad (8)$$

$$Xmax = (\lg (A / (Ymax\text{-}C) \text{-}1) \text{-}am) / b \quad (9)$$

$$Xmin = (\lg (A / (Ymin\text{-}C) \text{-}1) \text{-}am) / b \quad (10)$$

where Xmax and Xmin are values of the argument at the points where the function takes MINMAX.

4. To determine the similarity between experimental and theoretical points, analysis of variance was performed. Correlation coefficient, Fisher criterion were calculated.

5. Computational experiment. To determine an optimal ratio of time allotted for strength and coordination training, a computational experiment was conducted. Its essence is to create an array of data on 120 training modes and analyze the two-dimensional distribution. The computational experiment was conducted in two stages:

1. Based on the regression equations: $Y = b_0 + b_1x_1 + b_2x_2 + b_3x_1x_2$, where x_1 is the time allotted for strength training; x_2 – for coordination training, an array of data was created Y [i, j], where i is the counter of variants of training modes, j is the counter of analyzed parameters (increase in the result, time of achieving the result, time for strength, coordination training, technical training).

2. Analysis of the two-dimensional distribution of an increase in the result, time of achieving an optimal result, time for strength, coordination training, and teaching movements.

The obtained experimental material was processed statistically using statistical analysis software packages (SPSS 20).

The study protocol was approved by the Ethical Committee of the University. In addition, the children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents.

Results

The analysis of the study results is given in Tables 2-6. Math analysis of the logistic function made it possible to conclude about a similarity between experimental and theoretical points (Table 2).

Table 2. Results of the analysis of similarity between experimental and theoretical points calculated using the logistic function equation.

N	Test	Group 1			Group 2			Group 3			Group 4		
		R	F	p	R	F	p	R	F	p	R	F	p
1.	Grade for a unidirectional movement coordination exercise, points	0.937	0.003	<0.05	0.896	0.526	<0.05	0.838	0.051	<0.05	0.998	0.163	<0.05
2.	Grade for a multidirectional movement coordination exercise, points	0.489	0.272	<0.05	0.879	0.608	<0.05	0.980	0.087	<0.01	0.771	0.845	<0.05
3.	Error in time accuracy of performing the squat thrust	0.586	1.065	<0.05	0.936	0.399	<0.05	0.944	1.107	<0.05	0.512	0.568	<0.05
4.	Error in time accuracy of 5 jumps on marks in 5 s	0.482	0.854	<0.05	0.734	0.437	<0.05	0.925	0.454	<0.05	0.320	1.124	<0.05
5.	Error in assessing muscular effort with visual control	0.613	0.767	<0.05	0.526	0.049	<0.05	0.911	0.245	<0.05	0.708	1.189	<0.05
6.	Vestibular stability, error cm	0.874	0.002	<0.05	0.111	0.311	<0.05	0.964	0.112	<0.05	0.876	0.388	<0.05

The change in the ability to coordinate unidirectional and multidirectional movements is most influenced by variants of training 1 and 4. The boys of group 4 achieve a maximum result in 7.5 months, and the boys of group 1 — in 15 months (Table 3).

The change in the error in differentiating temporal characteristics of movement is positively influenced by variants of training 1, 3 and 4. Group 3, where maximum attention was paid to coordination training, shows the greatest speed in achieving a maximum result (Table 3).

The boys of group 3 show a higher result in less training time in differentiating muscular effort and in vestibular stability. It is noteworthy that achieving a similar result when using only the means of technical training takes twice as much time (Table 3).

According to the logistic function analysis, the achievement of an optimal result in differentiating temporal characteristics of movement requires 8.5 months, strength characteristics of movement – 8 months, movement coordination – 8 months, vestibular analyzer stability – 10 months. Thus, when planning physical education lessons during the 2nd and 3rd grades of training, it is necessary to allocate time for strength, coordination training, and teaching movements. The main means of developing motor abilities is basic gymnastics.

The analysis of the computational experiment showed that the increases in the results are normally distributed with a certain degree of assumption, and the arithmetic mean and the root mean square are the most important characteristics of the sample. The optimal step of increase is a value equal to M ± s, because the probability of achieving this result is the highest (Table 4).

Table 5 shows the ratio between the means of strength, coordination training and teaching in the class of boys aged 8-9 years.

It takes 3 to 5 months to obtain positive increases in testing results in boys aged 8-9. The ratio of time allotted for strength training (ST) and coordination training (CT) to teaching motor actions (TMA) varies as 1:4 (ST: TMA) and 1:4.5 (CT: TMA).

The process of teaching the most difficult movements for this age was similarly analyzed. Based on the computational experiment, it was determined that the results of training are normally distributed, and the arithmetic mean and the root mean square are the most important characteristics of the sample (Table 6).

Table 7 shows the ratio between the means of strength and coordination training when teaching movements to boys aged 8-9 years. It is noteworthy that as exercises become more complicated, the time allotted for strength and coordination training increases, but these indicators do not reach maximum values adopted in the experiment. The ratio of time allotted for strength training, coordination training, and teaching to the time of the main part of the class ranges between 14.3-23.5% (strength training), 17.1-23.5% (coordination training), and 53.0-68.6% (teaching).

Table 3. Results of the logistic function analysis. Optimal result (Y) and time of its achievement (t, months)

No	Test	Group 1		Group 2		Group 3		Group 4	
		Y	t	Y	t	Y	t	Y	t
1.	Grade for a unidirectional movement coordination exercise, points	9.59	15.34	8.447	7.74	8.835	15.26	**9.419**	**7.57**
2.	Grade for a multidirectional movement coordination exercise, points	9.49	27.72	8.788	8.70	7.596	9.02	**9.347**	**7.81**
3.	Error in time accuracy of performing the squat thrust	0.26	13.29	0.286	0.18	0.225	**12.62**	0.302	17.17
4.	Error in time accuracy of 5 jumps on marks in 5 s	0.35	27.50	**0.351**	**10.86**	**0.394**	**8.51**	0.392	26.04
5.	Error in assessing muscular effort with visual control, %	14.73	4.62	8.590	26.65	**7.470**	**10.04**	9.475	12.66
6.	Vestibular stability, error cm	6.56	19.26	**5.739**	**19.0**	5.975	9.82	8.174	7.06

Table 4. Computational experiment results. Elementary statistics

No	Test	X	s	As	Ex	λ	χ_2	N
1.	Grade for a unidirectional movement coordination exercise, points	1.878	1.117	-0.163	-0.709	1.442	74.762	120
2.	Grade for a multidirectional movement coordination exercise, points	2.628	1.466	-0.192	-0.738	1.558	147.638	120
3.	Error in time accuracy of performing the squat thrust	-0.254	0.238	-13.232	-1.315	1.130	69.453	120
4.	Error in time accuracy of 5 jumps on marks in 5 s	-0.268	0.151	194.021	-0.819	1.963	125.195	120
5.	Error in assessing muscular effort with visual control	-1.848	2.740	0.001	-1.067	1.154	39.674	120
6.	Vestibular stability, error cm	-1.119	0.740	0.222	-1.004	0.956	63.750	120

Table 5. Ratio between the means of strength and coordination training in the physical education class of boys aged 8-9 years

No	Test	Increase in the result	Time of achieving the result (months)		Strength training (min)		Coordination training (min)		Teaching motor actions (min)	
			Y	s	Y	s	Y	s	Y	s
1.	Grade for a unidirectional movement coordination exercise, points	2.814	3.021	0.386	8.41	2.27	3.692	2.25	22.897	4.452
2.	Grade for a multidirectional movement coordination exercise, points	4.025	3.092	0.155	4.533	2.51	5.933	1.58	24.533	3.966
3.	Error in time accuracy of performing the squat thrust	-0.432	5.031	0.189	4.111	1.328	5.083	3.088	25.806	4.336
4.	Error in time accuracy of 5 jumps on marks in 5 s	-0.396	4.601	0.817	4.974	3.03	3.385	2.451	26.641	2.144
5.	Error in assessing muscular effort with visual control	-4.478	4.597	0.663	7.238	2.437	6.214	2.19	21.548	0.791
6.	Vestibular stability, error cm	-1.844	3.136	0.544	5.524	3.384	7.143	1.406	22.333	1.399

Table 6. Computational experiment results. Elementary statistics. Boys aged 8-9 years

Exercise	X	s	As	Ex	λ	χ_2	N
Forward roll, (p=m/n)	0.895	0.064	-8.490	1.126	1.403	18.831	100
Straddle vault over side vaulting buck (p=m/n)	0.630	0.104	-7.436	-0.619	0.480	5.716	100

Table 7. Ratio between the means of strength and coordination training according to the indicators of teaching movements to boys aged 8-9 years

Exercise	Result	Strength training (min)		Coordination training (min)		Teaching motor actions (min)	
		Y	s	Y	s	Y	s
Forward roll, (p=m/n)	1. 0.936	5	1.885	6.071	2.01	23.929	5.744
Straddle vault over side vaulting buck, (p=m/n)	2. 0.735	8.25	2.5	8.063	1.611	18.687	2.324

Discussion

An assumption was made about the possibility of using factorial designs and analysis of the logistic function to assess the effectiveness of different structures of physical education classes in junior school. The study established the effectiveness of the algorithm of computer modeling of the structure of physical education classes.

During the analysis, the study determined the structure of the main part of the class, which ensures the effectiveness of motor abilities and motor skills development.

The obtained data supplement the information on the factors that influence the effectiveness of motor skills development [14-16]; on the technique of pedagogical control in the process of motor skills development [17-19]; confirm the information that the conditions for motor skills development are one of the factors that determine the effectiveness of teaching schoolchildren [1, 10-12].

In addition, the study supplements the data on the effectiveness of using factorial designs in studying the patterns of motor skills development [28, 29]. Also, the results of the study confirm the effectiveness of using the logistic function to determine the duration of training and motor abilities development in children and adolescents [30, 31].

The results of the study can be used to plan strength and coordination training, and teaching basic gymnastics exercises in junior school physical education classes. The data given in Tables 5 and 7 are recommended for planning. The main method of strength development is the combined method according to the first variant. Exercises at one place are performed in the following order: dynamic effort method, maximal effort method, isometric effort method, repeated effort method. The development of strength and movement coordination is seen as a condition for successful motor skills development.

Conclusions

The logistic function analysis showed that the achievement of an optimal result in differentiating temporal characteristics of movement requires 8.5 months, strength characteristics of movement and movement coordination – 8 months, vestibular analyzer stability – 10 months. When planning physical education lessons during the 2nd and 3rd grades of training, it is necessary to allocate time for strength, coordination training, and teaching movements. The main means of developing motor abilities is basic gymnastics.

The ratio of time allotted for strength, coordination training, and teaching to the main part of the class ranges between 14.3-23.5% (strength training), 17.1-23.5% (coordination training), and 53.0-68.6% (teaching). As exercises become more complicated, the time allotted for strength and coordination training increases.

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Conflict of interest

The authors declare no conflict of interest.

References

1. Petrov D, Khudolii O, Cieślicka M. Motor Skills: Motor Fitness Structure of 9-Year-Old Boys. *Journal of Learning Theory and Methodology,* 2020; 1(2): 58–63. https://doi.org/10.17309/jltm.2020.2.02
2. Agosti V, Madonna G. From movement to action: New perspectives in motor learning and sport training. *Sport Science,* 2020; 14: 40–43.
3. Bjørke L, Mordal Moen K. Cooperative learning in physical education: A study of students' learning journey over 24 lessons. *Physical Education and Sport Pedagogy*, 2020; 25(6): 600–612. https://doi.org/10.1080/17408989.2020.1761955
4. Bores-García D, Hortigüela-Alcalá D, Fernandez-Rio FJ, González-Calvo G, Barba-Martín R. Research on Cooperative Learning in Physical Education: Systematic Review of the Last Five Years. *Research Quarterly for Exercise and Sport,* 2021; 92(1): 146–155. https://doi.org/10.1080/02701367.2020.1719276
5. Capella-Peris C, Gil-Gómez J, Chiva-Bartoll Ò. Innovative analysis of service-learning effects in physical education: A mixed-methods approach. *Journal of Teaching in Physical Education*, 2020; 39(1): 102–110. https://doi.org/10.1123/jtpe.2019-0030
6. Coimbra M, Cody R, Kreppke J-N, Gerber M. Impact of a physical education-based behavioural skill training program on cognitive antecedents and exercise and sport behaviour among adolescents: A cluster-randomized controlled trial. *Physical Education and Sport Pedagogy*, 2021; 26(1): 16–35.

https://doi.org/10.1080/17408989.2020.1799966
7. Gaetano R. Motor learning and didactics into physical education and sport documents in middle school-first cycle of education in Italy. *Journal of Physical Education and Sport*, 2012; 12(2): 157–163.
8. Raiola G. Motor learning and teaching method. *Journal of Physical Education and Sport,* 2017; 17: 2239–2243. https://doi.org/10.7752/jpes.2017.s5236
9. Barnett LM, Telford RM, Strugnell C, Rudd J, Olive LS, Telford RD. Impact of cultural background on fundamental movement skill and its correlates. *Journal of Sports Sciences,* 2019; 37(5), 492–499. https://doi.org/10.1080/02640414.2018.1508399
10. Marchenko S, Bezpalko D. Control and Assessment of 7-Year-Old Boys' Coordination Abilities at the Initial Training Stage in Kyokushin Karate. *Journal of Learning Theory and Methodology*, 2020; 1(2): 82–88. https://doi.org/10.17309/jltm.2020.2.06
11. Thienes G, Glage D. Influence of motor coordination on learning a gross motor task. *German Journal of Exercise and Sport Research,* 2020; 50(1): 60–70. https://doi.org/10.1007/s12662-019-00626-w
12. Ivashchenko O, Berezhna H, Cieślicka M. Motor Skills in the Structure of Physical Fitness of 7-Year-Old Boys. *Journal of Learning Theory and Methodology,* 2020;1(1): 14–19. https://doi.org/10.17309/jltm.2020.1.02
13. Marmeleira J, Folgado H, Martínez Guardado I, Batalha N. Grading in Portuguese secondary school physical education: Assessment parameters, gender differences and associations with academic achievement. *Physical Education and Sport Pedagogy,* 2020; 25(2): 119–136. https://doi.org/10.1080/17408989.2019.1692807
14. Hiley MJ, Schmid N, Yeadon MR. How do technique and coordination change during learning of a whole-body task: Application to the upstart in gymnastics. *Journal of Sports Sciences*, 2019; 37(20): 2374–2380. https://doi.org/10.1080/02640414.2019.1634413
15. Meier C, Fett J, Gröben B. The influence of analogy instruction and motion rule instruction on the learning process of junior tennis players: Qualitative assessment of serve performance. *German Journal of Exercise and Sport Research,* 2019; 49(3): 291–303. https://doi.org/10.1007/s12662-019-00589-y
16. North JS, Bezodis NE, Murphy CP, Runswick OR, Pocock C, Roca A. The effect of consistent and varied follow-through practice schedules on learning a table tennis backhand. *Journal of Sports Sciences*, 2019; 37(6): 613–620. https://doi.org/10.1080/02640414.2018.1522683
17. Aiken CA, Post PG, Hout MC, Fairbrother JT. Self-controlled amount and pacing of practice facilitate learning of a sequential timing task. *Journal of Sports Sciences,* 2020; 38(4): 405–415. https://doi.org/10.1080/02640414.2019.1704498
18. Di Palma D, Cusano P. Evaluation techniques and strategies applied to experimental educational projects for motor learning through the practice of karate. *Sport Science*, 2020; 14: 60–66.
19. D'isanto T. Competencies and skills in exercise and sport sciences program by online education. *Sport Science,* 2020; 13(1): 95–98.
20. Bolger LA, Bolger LE, O'Neill C, Coughlan E, Lacey S, O'Brien W, Burns C. Fundamental Movement Skill Proficiency and Health Among a Cohort of Irish Primary School Children. *Research Quarterly for Exercise and Sport,* 2019; 90(1): 24–35. https://doi.org/10.1080/02701367.2018.1563271
21. Bolger LE, Bolger LA, O'Neill C, Coughlan E, O'Brien W, Lacey S, et al. Global levels of fundamental motor skills in children: A systematic review. *Journal of Sports Sciences,* 2021;39:717–53. https://doi.org/10.1080/02640414.2020.1841405
22. Freitas E, Saimpont A, Blache Y, Debarnot U. Acquisition and consolidation of sequential footstep movements with physical and motor imagery practice. *Scandinavian Journal of Medicine and Science in Sports*, 2020; 30(12): 2477–2484. https://doi.org/10.1111/sms.13799
23. Elghoul Y, Bahri F, Souissi MA, Chaâri N, Souissi N, Frikha M. Difficulty-manipulation-based learning effects on throwing performances and achievement goals in young boys. *Acta Gymnica*, 2021; 51. https://doi.org/10.5507/AG.2021.005
24. González-Víllora S, Evangelio C, Sierra-Díaz J, Fernández-Río J. Hybridizing pedagogical models: A systematic review. *European Physical Education Review*, 2019; 25(4): 1056–1074. https://doi.org/10.1177/1356336X18797363
25. Krause L, Farrow D, Pinder R, Buszard T, Kovalchik, S, Reid M. Enhancing skill transfer in tennis using representative learning design. *Journal of Sports Sciences,* 2019; 37(22): 2560–2568. https://doi.org/10.1080/02640414.2019.1647739
26. Chan CHS, Ha ASC, Ng JYY, Lubans, DR. Associations between fundamental movement skill competence, physical activity and psycho-social determinants in Hong Kong Chinese children. *Journal of Sports Sciences,* 2019; 37(2): 229–236. https://doi.org/10.1080/02640414.2018.1490055
27. Chang SH, Ward P, Goodway JD. The effect of a content knowledge teacher professional workshop on enacted pedagogical content knowledge and student learning in a throwing unit. *Physical Education and Sport Pedagogy,* 2020; 25(5): 493–508. https://doi.org/10.1080/17408989.2020.1743252
28. Marchenko S, Taranenko O. Managing the Effectiveness of Teaching Boys Aged 10 Mawashi-Geri (Roundhouse Kick) Technique in Kyokushin Karate. *Teorìâ ta Metodika Fìzičnogo Vihovannâ,* 2020; 20(4): 262–268. https://doi.org/10.17309/tmfv.2020.4.10
29. Khudolii OM, Ivashchenko OV, Iermakov SS, Rumba OG. Computer simulation of Junior gymnasts' training process. *Science of Gymnastics Journal,* 2016; 8(3): 215–228.
30. Lopatiev A, Ivashchenko O, Khudolii O, Pjanylo Y, Chernenko S, Yermakova T. Systemic approach and mathematical modeling in physical education and sports. *Journal of Physical Education and Sport*, 2017; 17(s1): 146–155. https://doi.org/10.7752/jpes.2017.s1023
31. Khudolii O. Research Program: Modeling of Young Gymnasts' Training Process. *Teorìâ ta Metodika Fìzičnogo Vihovannâ,* 2019; 19(4): 168–178. https://doi.org/10.17309/tmfv.2019.4.02

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SUBMISSION OF MANUSCRIPTS

(For more detailed information see http://www.sportpedagogy.org.ua/index.php/PPS/pages/view/trebovaniya-e)
Structure of article:
- title of an article;
- surname, full first name and patronymic;
- full name of organization (place of work or study);
- annotation in three language (Russian, Ukrainian, English). The scope of the annotation is to be 800-1000 symbols.

Annotation must contain translate of surname, full first name and patronymic of authors, in Ukrainian (Russian) and English. Structure of annotation: *Purpose, Material, Results, Conclusions*. For authors from Russia, the translation in the Ukrainian language makes editorial board.

Key words for the three languages: (4-6 words).

Introduction

Hypothesis, Purpose

Material and methods

Participants.
Research Design.
Statistical Analysis

Results

Discussion

Conclusions

Conflict of interests

References (more than 20) should be making up according to standard form.

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