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IMPACT OF TRAINING PROGRAM FOR THE DEVELOPMENT OF EXPLOSIVE FORCE ON SOME SPECIFIC MOTOR SKILLS IN 14-YEAR OLD STUDENTS

Original scientific paper

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Abstract

The purpose of this study is to confirm the impact of the training model for the development of explosive force on some specific motor skills. The research was conducted on a sample of 170 male partiicpants, aged 14 years ± 6 months, students of primary schools "Naim Frashëri" and "Bajram Shabani" - Kumanovo. A total of 9 specific motor variables were used in this research, of which: 6 variables for the evaluation of explosive force including: left foot triple jump, right foot triple jump, standing high jump, standing quintuple jump, standing long jump and standing triple jump and 3 variables for evaluating sprinting as well: 30 meters running, 80 meters running 100 meters running. The research was longitudinal in nature, and lasted a total of 12 weeks, with 36 hours of training. To verify the differences between the control and experimental groups in the initial and final measurements, univariate and multivariate analysis of variance (ANOVA-MANOVA) and covariance (ANCOVA – MANCOVA) was used. From this research, we can conclude that variables for assessing specific motor abilities have statistically significant differences with probability 0.001 between the control and experimental group in the initial measurements, in only 4 variables out of 9 motor-specific variables, while after applying the experimental model, in the final measurements, we can observe that all motor-specific variables have statistically significant differences with the probability of 0.001 between the control and experimental groups.

Thus we can prove that this training model has a significant influence on the development of explosive force, as well as other motor skills such as speed and agility, and the same pattern can be used in top sportspersons.

Keywords: *explosive force model, specific motor skills, training process, elementary school students*

INTRODUCTION

The motor skills are predetermined genetic characteristics that influence movement performance. Each motor skill performs a specific function and involves precise movement of the muscles, to perform a specific act. Motor skills development requires the integration of motor activities in schools and at home environment, which can be of great help to students in school and sports activities, as well as having a positive impact on reading, writing, concentration and memory. Strength and speed are the basis for many sports activities, while explosive force is part of the force system, but can also be counted as a system in which the myotatic reflex, that is, the muscle extension reflex, has a leading role. The basic types of training to further improve myogenic characteristics are plyometric training and models of training of explosive force development. Plyometric exercises help athletes improve motor skills such as strength, speed, and agility (Potach & Chu, 2000). Training programs containing jumping and plyometric exercises have a positive effect on increasing explosive force and speed (Chu, 1993). Various researchers have shown that plyometric training, especially when used with a well-designed program or model and passed on to athletes over a longer period, can contribute to improved performance in long jump types as well as muscular strength of the legs (Miller et al., 2006). Fatouros et al. (2000), compared the impact of three different explosive force development programs. Plyometric training, weight training and a combination of both programs. The total number of tested students was 41, divided into 3 groups. The training lasted 12 weeks with 3 hours per week and produced positive results in all groups (p <0.005). The group that attended the combined training had significantly better results than the other two groups. This paper aims to determine the impact of a training program on the development of explosive force on some motor - specific skills in students.

METHODS

Sample of participants

The sample of the participants comprises 170 pupils of "Naim Frasheri" and "Bajram Shabani" - Kumanovo primary schools. Tested students have normal health features and are divided into two groups: group A which is Experimental group (EG), (n = 90; average height 167.50 cm, average weight 59.40 kg, BMI 21.096), who in addition to regular physical education classes, they also attended three additional classes per week of explosive force training system, and group B: Control group (CG) with following characteristics: n = 80; average height 166.86 cm, average weight 58,190 kg, BMI 20.80), who were not active in any special training process, in addition to regular physical education classes.

Sample of variables

The sample of the variables consists of a total of 9 specific motor tests, of which: 6 variables for the evaluation of explosive force including: 1) left foot triple jump (SMLFTJ), 2) right foot triple jump (SMRFTJ), 3) standing high jump (SMSHJ), 4) standing quadruple jump (SMSQJ), 5) standing long jump (SMSLJ) and 6) standing triple jump (SMSTJ), and 3 variables for evaluating sprint running,

Table 1. Descriptive characteristics of groups (arithmetic mean; standard deviation)

Variables	Control group (n=80)				Experimental group (n=90)			
	Mean		St.dev.		Mean		St.dev.	
	IT	FT	IT	FT	IT	FT	IT	FT
Age	14.3	14.6	2.63	2.54	14.6	14.9	2.78	2.63
Height	166.86	168.275	8.469	8.187	167.506	170.406	7.32	7.176
Weight	58.190	59.36	11.196	11.284	59.406	60.255	11.83	11.322
BMI	20.807	20.877	3.304	3.241	21.096	20.735	3.790	3.639

Table 2. Representation of experimental program classes (modified by Antekolovic et al. 2004)

Experimental program	Number of classes
General and basic physical training program	9
Explosive force	4
Primary velocity factors	3
Overall durability	2
Specific-physical preparation program for the development of explosive force	27
Preparatory exercises in motion	8
Depth jumps in the Swedish mass	3
Stretching exercises	4
Depth jumps in Swedish box	6
Depth jumps at stations	6

such as: 7) running at 30 meters (RU30m), 8) running at 80 meters (RU80m) and 9) running at 100 meters (RU100m). Measuring instruments were implemented according recommendations of the authors Milanovic (1981), Asllani (2007), Radic & Simeonov (2009), Iseni (2016).

Description of the experimental program

The model of the three-month explosive training program was applied only to the experimental group, which in addition to regular physical education classes organized a training program of three classes per week, a total of 36 classes of training per week, lasting for 12 weeks. Control group participants were not active in the process of any special training except regular physical education classes. We have divided each class of the three-month explosive training program of the experimental group into four parts: the introductory section (8-10 minutes), the preparatory section (10-15 min), the main section (25- 30 min) and the final section (8-15 min). The training program applied in this research is composed of various movements, such as: jogging, sprints, one-and-two-foot jumps, stretching, depth jumps, depth jumps with Swedish measures, and depth jumps at stations. This training model was also applied based on recommendations and results from studies of Asllani (2007) and Jakovljevic (2013). This training model is described in Table 2. The experimental program is modified by Antekolovic, Zufar & Hofman (2004).

Statistical analysis

The results of this study were processed with the statistical software SPSS version 22.0. To verify the differences between the control and experimental groups in the initial measurements, univariate and multivariate analysis of variance (ANOVA-MANOVA) was used, while the differences between the groups in the final measurements were divided by dividing the difference between the groups in the initial measurements to determine the effects of the experimental program of explosive force development, univariate and multivariate analysis of covariance (ANCOVA - MANCOVA) was used. The results were analyzed on $p<0.001$ level of significance.

RESULTS

The results from statistical analyses are presented in Tables 3 and 4. The summary of the mean values of the control and experimental group on the basic statistical parameters of the motor-specific abilities in the initial and final measurements are presented in Table 3. It is seen that there are significant differences between groups in different measurement situations for all these variables. There are also differences between the mean values of the same group compared to the initial and final measurements. According to the standard deviation values as the main dispersive indicator, it can be concluded that most of the motor-specific variables in the initial and final measurements are normally and symmetrically distributed. The curve asymmetry (skewness) is small in almost all variables, and some even in negative values. The approximate value (kurtosis) of the curve for most variables is below 2.75, so all of these values are platycurtic in nature, meaning that the results are distributed by the arithmetic mean.

From the summary of results presented in Table 4, which shows the multivariate analysis of variance (MANOVA) on the motor-specific variables between the two groups of participants (control and experimental groups) in the initial measurements, it can be observed that there are statistically significant differences between the groups in the specific-motor space. This can be seen from Wilks' Lambda .82, which approximates Rao's F of 3.750, and with degrees of freedom df1 = 9 and df2 = 160, gives importance to differences between groups at the Q level (F) test = .00.

From inspection of the Table 5, we showed the results of univariate analysis of variance (ANOVA) on specific motor variables between the experimental and control groups in the initial measurements. From the overview of the arithmetic mean values, for each indicator individually, it can be observed that statistically significant differences between the experimental group and control on motor-specific abilities are found in 5 of the 9 variables investigated in this study: left foot triple jump (SMLFTJ), with reliability level (.00), right foot triple jump (SMRFTJ), with reliability level (.00), standing quadruple jump (SMSQJ), with reliability level (.00), standing triple jump (SMSTJ), with reliability level (.00) and running at 30 meters (RU30m), with reliability level (.02), while for the other variables there were no statistically significant differences between the experimental and control groups.

Table 6 presents the results of multivariate analysis of covariance (MANCOVA) between the experimental and control groups, in the final measurements by partitioning and neutralization of differences of mean values from initial measurements, it can be observed that there are statistically significant differences between groups in the motor-specific space. This can be seen from Wilks' Lambda .37, which approximates Rao's F of 27,853, and with degrees of freedom df1 = 9 and df2 = 151, giving importance to differences between groups at level Q (F) test = .00. From this analysis, it can be seen that the explosive force development program applied in the experimental period had a statistically significant influence on the process of transforming motor-specific abilities in the experimental group compared to the control group.

From the data provided in Table 7, representing the results of the covariance univariate analysis (ANCOVA), between the experimental and control group in the final measurements by partitioning and neutralization of differences of mean values from initial measurements, it can be observed that in all the motor-specific variables there were significant statistical differences ($Q<.05$), even in all tests in favor of the experimental group. The differences are in the variables: left foot triple jump (SMLFTJ), (.00), right foot triple jump (SMRFTJ), (.00), standing high jump (SMSHJ), (.00), standing quadruple jump (SMSQJ), (.00), standing long jump (SMSLJ), (.00), standing triple jump (SMSTJ), (.00), 30m running (RU30m), (.00), 80m running (RU80m), (.00), and 100m running (RU100m), (.00). From this, it can be concluded that the program used for the development of explosive force causes a quantitative improvement with statistical significance in the development of specific-motor tests in participants of the experimental group.

DISCUSSION

In this study, the main purpose is to validate the impact of the training model on the development of explosive force on some mo-

Table 3. Basic statistical parameters of specific-motor variables - control and experimental Group in initial and final measurements

Variables	Group	Mean		St.dev.		Mean		St.dev.	
		IT	FT	IT	FT	IT	FT	IT	FT
SMLFTJ	Control	451.88	475.17	73.21	77.31	.402	-.111	-.187	-.436
	Experimental	489.001	576.72	85.30	85.45	-.106	-.502	.559	-.046
SMRFTJ	Control	455.46	483.92	67.80	74.36	-.031	-.347	.241	.065
	Experimental	496.33	578.72	84.98	81.92	-.582	-.786	.152	.334
SMSHJ	Control	32.57	36.80	7.59	7.18	.085	-.057	-.784	-.126
	Experimental	33.33	41.57	8.46	8.01	-.079	-.048	-.002	-.484
SMSQJ	Control	829.78	879.71	126.67	117.31	-.240	-.420	.755	-.506
	Experimental	899.11	1023.64	131.25	107.54	-.231	-.415	-.435	-.026
SMSLJ	Control	169.83	178.66	25.002	22.30	.058	-.433	-.115	-.286
	Experimental	172.05	193.72	24.16	28.17	-.197	-.285	.017	-.302
SMSTJ	Control	482.75	505.06	63.89	68.82	-.050	-.522	-.481	-.198
	Experimental	511.80	588.62	66.80	76.92	-.080	-.375	-.414	.018
RU30m	Control	4.94	5.66	.446	.750	-.210	.870	-.788	1.851
	Experimental	4.77	4.59	.528	.449	.672	.812	-.153	.021
RU80m	Control	11.81	12.31	1.38	1.46	.414	.112	.353	-.560
	Experimental	11.55	11.20	1.36	1.19	.833	.904	.113	.041
RU100m	Control	15.48	15.82	1.82	1.54	.367	-.012	.112	-.171
	Experimental	14.99	14.44	1.71	1.36	.987	.851	.516	.017

Key: IT - initial measurements, FT - final measurements

Table no. 4 Multivariate analysis of variance (MANOVA) at specific-motor variables between control and experimental group in initial measurements

Effect	Value	F	Hypothesis df	Error df	Sig.
GR	.174	3.750[b]	9.000	160.000	.000
	.826	3.750[b]	9.000	160.000	.000
	.211	3.750[b]	9.000	160.000	.000
	.211	3.750[b]	9.000	160.000	.000

Table 5. Univariate analysis of variance (ANOVA) on specific-motor variables between control and experimental groups in initial measurements

Variables		Sum of Squares	df	Mean Square	F	Sig.
SMLFTJ	Contrast	58334.301	1	58334.301	9.149	.003
	Error	1071115.988	168	6375.690		
SMRFTJ	Contrast	70747.413	1	70747.413	11.814	.001
	Error	1006063.888	168	5988.476		
SMSHJ	Contrast	24.356	1	24.356	.374	.542
	Error	10935.550	168	65.093		
SMSQJ	Contrast	203538.200	1	203538.200	12.208	.001
	Error	2800912.276	168	16672.097		
SMSLJ	Contrast	208.367	1	208.367	.345	.557
	Error	101335.610	168	603.188		
SMSTJ	Contrast	35741.753	1	35741.753	8.343	.004
	Error	719693.400	168	4283.889		
RU30m	Contrast	1.222	1	1.222	5.053	.026
	Error	40.612	168	.242		
RU80m	Contrast	2.864	1	2.864	1.523	.219
	Error	316.038	168	1.881		
RU100m	Contrast	10.018	1	10.018	3.194	.076
	Error	526.935	168	3.137		

Table 6. Multivariate analysis of covariance (MANCOVA) on specific motor variables between control and experimental groups in final measurements with neutralization of differences with initial measurements

Effect		Value	F	Hypothesis df	Error df	Sig.
GR	Pillai's Trace	.624	27,853[a]	9.000	151.000	.000
	Wilks' Lambda	.376	27,853[a]	9.000	151.000	.000
	Hotelling's Trace	1.660	27,853[a]	9.000	151.000	.000
	Roy's Largest Root	1.660	27,853[a]	9.000	151.000	.000

tor-specific abilities. Examination of the results in the initial measurements in both research subjects, in the control and the experimental, revealed that there were statistically significant differences in the motor-specific abilities, but only in 5 of the 9 studied variables. After applying the training model for explosive force development, which training model lasted 12 weeks and was subjected only to the experimental group, by examining the final measurements, it was found that there are statistically significant differences in the motor-specific abilities in all 9 variables, where the research results obtained were in favor of the experimental group compared to the control group.

Table 7. Univariate analysis of covariance (ANCOVA) in specific-motor variables between control and experimental groups in final measurements with neutralization of differences with initial measurements

Variables		Sum of Squares	df	Mean Square	F	Sig.
SMLFTJ_F	Contrast	221851.032	1	221851.032	94.314	.000
	Error	374007.599	159	2352.249		
SMRFTJ_F	Contrast	182549.249	1	182549.249	78.143	.000
	Error	371437.818	159	2336.087		
SMSHJ_F	Contrast	365.190	1	365.190	13.706	.000
	Error	4236.531	159	26.645		
SMSQJ_F	Contrast	435331.520	1	435331.520	86.846	.000
	Error	797013.829	159	5012.666		
SMSLJ_F	Contrast	3095.052	1	3095.052	15.953	.000
	Error	30847.662	159	194.010		
SMSTJ_F	Contrast	142502.651	1	142502.651	62.452	.000
	Error	362805.812	159	2281.798		
RU30m_F	Contrast	28.457	1	28.457	144.201	.000
	Error	31.377	159	.197		
RU80m_F	Contrast	20.943	1	20.943	46.629	.000
	Error	71.412	159	.449		
RU100m_F	Contrast	35.963	1	35.963	76.061	.000
	Error	75.179	159	.473		

Dalwinder & Sukhwinder (2013) tested the plyometric program in 80 students over 10 weeks and concluded that this training model improved the results in the sprint running in favor of the experimental group. Significant results, in a sample of 16 students over a period of 8 weeks, Elsayed (2012) obtained by applying plyometric training to some length jumps. Herrero et al. (2006) by combining the plyometric program with the electro stimulator in 40 students over a 4 weeks, significantly improved the results in high jump and sprint running. Also, Fischeti et al. (2018) reported that 8-week plyometric training has positively improved lower limb speed and explosive strength in 14-year-old students. Jakoljevic & Batricevic (2008) applied for an explosive force development program in 38 pupils aged 14, for a period of 8 weeks, and at the end of the experiment, it was concluded that this training model had a positive effect on the improvement of segmental force, repetitive force and explosive force and some functional abilities. Lubbers et al. (2003) came up with important results during the application of plyometric training in long jumps and anaerobic force, especially when after the application of the plyometric training model which lasted 4 weeks, another 4 weeks of recovery phase was realized. The study of Faigenbaum et al. (2007) was used a 6-week plyometric and resistance training program for students aged 12-15 years, which concluded that a plyometric program was more effective than resistance training in improving motor performance. Asadi & Ramirez-Campillo (2016) conducted a study of 30 students aged 19 years old with significant statistical differences in explosive force, sprint and agility tests in the experimental group following plyometric model in the period of 6 weeks. Significant statistical differences were found in the final measurements between the experimental and control groups, and also the experimental group showed better results than the control group after the implementation of the 8-week plyometric program, which significantly improved the results in flexibility, speed, explosive strength and agility in students, Erdogan et al. (2014). We also have many other studies that tackle similar themes of the impact of plyometric programs and combined models but on selective samples or professional athletes. Kryeziu et al. (2019) reported that 4-week plyometric training improved the explosive strength of the lower limbs and agility in 15-year-old basketball players. Impellizzeri et al. (2008) tested a plyometric program in 37 soccer players over a 4 weeks, concluding that this training model improved performance in jumps and sprint running. Hermassi et al. (2014) reported that 8-week plyometric training significantly improved lower limb strength and jumping performance, which program was applied during the racing season in elite handball players aged 20 years.

CONCLUSION

From the analysis of the results and discussions, we can conclude that the modified 12 - week model for explosive force development had a positive effect on improving the motor - specific abilities of the students, specifically, it improved the experimental group results in the final measurements on jumps and sprint running. From this experiment, we can confirm that this type of training program should at the same time be a model for all sports lecturers, trainers and researchers who want to enhance the sports performance of students and athletes.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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