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Original scientific paper

THE EFFECT OF THE PLYOMETRIC PROGRAM IN THE LONG JUMP AND TRIPLE JUMP AT STUDENTS

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Abstract

The aim of this research is to prove the effect of plyometric program for the development of explosive force on the performance of long jump and triple jump in students. The research was conducted on a sample of 220 male testers aged 15 years ± 6 months, students at high schools "Sami Frashëri" and "Ismet Jashari" - Kumanovo. In this research, were used a total of 2 specific-motor variables for the evaluation of long jumps: 1) long jump –gathering technique (SMLJG) and 2) triple jump (SMTJ). The research had a longitidunal character, and lasted a total of 12 weeks, with 36 hours of training. In order to confirm the differences between the control and experimental groups, in the initial and final measurements, were used univariate and multivariate analysis of variance and covariance. From this research we can conclude that the variables for the assessment of specific motor skills do not have statistically significant differences between the control and experimental group in the initial measurements, while after applying the experimental model in the final measurements, we can see that the two specific-motor variables have statistically significant differences with probabilities 0.017 and 0.049 between the control and experimental group, which can prove that this training model has a significant impact on the development of explosive force in the performance of long jump and triple jump, and the same model can be used on elite athletes.

Keywords: plyometric model, specific motor skills, training process, long jump, triple jump, students.

1. Introduction

Long jumps require great precision and perfect coordination movements and adaptive psychophysical skills. The length of the long jump depends on the magnitude of the initial flight speed, angle and height of the body weight near the flight phase. From a biomechanical point of view the length of the jump depends on the following components: momentum, propulsive impulse and free limb oscillation. Also the triple jump according to the technique of implementation is a very complicated athletic discipline. The flight length of the triple jump depends on: the horizontal velocity of the momentum, the intensity of the impulse force, the angle of flight, the height of the athlete's weight after each push from the ground, and the optimal ratio of the length of the first, second and third jump (Asllani, 2016). To enhance the psycho-motor skills of these disciplines, jumpers use various training tools and models, because long jumpers must possess great speed, explosive strength, mobility and dexterity. The capacity to improve performance in professional and recreational athletes is the main goal of sporting performance, while plyometric training ranks among the most widely used methods for developing the aforementioned profiles. Plyometric exercises are used to improve explosive strength and prevent injuries. These exercises have been shown to be very effective (de Villareal et al. 2009), where we have a large number of studies in where are recommended different plyometric intensities and recovery periods after training (Jensen et al., 2008; Ebben et. al., 2010). Practitioners who design plyometric programs should describe low-volume to moderate periodic plyometric training as higher volume programs offer with no additional benefits. Higher volume programs are less efficient at times. Post-workout testing, and possibly participation in sports, should occur more than 2 days after the training period, with the optimal training benefits expressed between 6 days and 2 weeks after training (Ebben et al., 2014). Several research studies have confirmed that plyometric training can increase muscle strength and power (Markovic et al., 2007), speed

(Diallo et al., 2001; Michailidis et al., 2013) and agility (Arazi et al., 2012; Ramirez-Campillo et al. authors, 2014). Exercise adaptations in the development of sprinting and jumping skills are more variable, indicating an initial increase over the ages of 5–9 years, which is followed by a second period of rapid improvement during puberty (Meyers, 2017). Plyometric training is effective in increasing athletic performance in sprint running and jumping in athletes before puberty (Ramirez-Campillo, 2018). Plyometric exercises and well-designed programs for the development of explosive force have positive effects on the development and improvement of morpho-functional and motor skills such as speed, strength and agility in students and athletes (Chu, 1993; Potach & Chu, 2000). Recently, (Moran and authors, 2017) reported that plyometric training caused small effects (d = 0.57) on long jump performance in young girls (8-18 years old), while there is limited evidence on the extent to which girls pre-puberty adapt to plyometric exercise. The purpose of this paper is to prove the effectiveness of the 12-week plyometric training program in the performance of long jump – gathering technique and triple jump in 15-year-old students.

2. Methods

Sample of participants

The sample of participants consists of 220 students at high schools "Sami Frashëri" and "Ismet Jashari" - Kumanovo. The testers are in normal health condition, and are divided into two groups: group A: Experimental, (EG, n = 115; height 169.3 cm, weight 60.4 kg, BMI 21.1), who in addition to exercises in regular physical education classes three additional hours per week of the system of exercises for the development of explosive force were followed, and group B: Control, (CG, n = 105; height 168.8 cm, weight 56.8 kg, BMI 19.9), who were not active in any process special exercise, in addition to exercises in the regular hours of physical education.

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

Variables	Control group (n=105)				Experimental group (n=90)			
	Mean		Standard deviation		Mean		Standard deviation	
	IT	FT	IT	FT	IT	FT	IT	FT
Age	15.5	15.6	2.43	2.36	15.6	15.9	2.76	2.61
Height	168.1	168.8	7.24	7.42	168.6	169.3	6.672	6.864
Weight	56.8	56.8	10.65	10.33	56.7	60.4	8.74	8.53
BMI	20.807	20.877	3.304	3.241	21.096	20.735	3.790	3.639

Sample of variables

The sample of variables consists of a total of 2 specific - motor tests, namely: 1) long jump – gatherting technique (SMLJGT) 2) long jump - triple (SMLJT). Measuring instruments were implemented based on the authors (Milanovic, 1981; Asllani, 2007; Radic & Simeonov, 2009; Iseni, 2016).

The description of the experimental program

The model of the quarterly plyometric training program for the development of explosive force was applied only with the experimental group, who, in addition to exercises in physical education classes within the framework of regular teaching, organized a training system with three additional hours per week, a total of 36 hours of training for a period of 12 weeks. The control group testers were not active in the process of any special training, except for regular physical education classes. Each hour of the quarterly training program for the development of explosive force in the experimental group, we have divided into four parts, namely: the introductory part (8-10 minutes), the preparatory part (10-15 minutes), the main part (25- 30 min.) And the final part (8-15 min.). The plyometric program applied in this research is composed of different movements, such as: running, sprints, one- and double leg jumps, extensions, deep jumps, Swedish depth jumps, and depth jumps at stations. This training model was applied based on the publications of the authors (Asllani, 2007; Jakovljevic, 2013, Iseni, 2016). This training model is described in Table 2 (experimental program modified by Antekolovic et al. 2004).

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

Experimental program	Number of hours
General and basic physical training program	9
Explosive force	4
The primary speed factors	3
Overall durability	2
Specific-physical training program for the development of explosive force	27
Preparatory exercises in motion	8
Depth jumps in the Swedish mass	3
Extension exercises	4
Depth jumps in Swedish box	6
Depth jumps at stations	6

Statistical analysis

The results of this study were processed with the statistical program SPSS version 22.0. In order to verify the differences between the control and experimental group in the initial measurements, it was used univariate and multivariate analysis of variance (ANOVA-MANOVA), while to determine the differences between groups in the final measurements by dividing the difference between the groups in the initial measurements and to determine the effects of the experimental program of explosive force development, it was used univariate and multivariate analysis of covariance (ANCOVA - MANCOVA).

3. Results

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

Variables	Group	Mean		Standard deviation		Skewness		Kurtosis	
		IT	FT	IT	FT	IT	FT	IT	FT
SMLJG	Control	354.4	371.0	47.99	47.52	.19	.69	2.67	3.00
	Experimental	364.1	447.0	48.47	50.63	.18	.04	2.95	2.75
SMTJ	Control	715.1	722.2	98.25	97.06	-.70	-.78	1.19	1.20
	Experimental	724.2	745.5	85.55	84.99	-.46	-.44	2.72	1.10

Legend: IT - initial measurements, FT - final measurements

Table no.3 gives us a summary of the average values of the control and experimental group on the basic statistical parameters of specific motor skills in the initial and final measurements. It is seen that there are obvious 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 specific-motor variables in the initial and final measurements are normally and symmetrically distributed. The asymmetry of the curve (skewness) is small in almost all variables, and in some with negative values. The value of the curvature of the curve in the variable long jump in the control group in the initial measurements and the triple jump variable in both the control and experimental group in the initial and final measurements is below than 2.75, so that all these values are of a platykurtic character, which means that the results are distributed by arithmetic mean, while in the variable long jump in the control group in the final measurements and also in the experimental group in the initial and final measurements we have values above than 2.75, so that these values have a mesokurtic character.

Table 4. Multivariate analysis of variance (MANOVA) in specific-motor variables between control and experimental group in initial measurements

WILK'S LAMBDA TEST	.996
Rao's F approximation	.402
Q	.670

From the summary of table no. 4, which shows the multivariate analysis of variance (MANOVA), to the specific-motor variables between the two groups of entities (control and experimental group), in the initial measurements, there are no statistically significant differences between groups in the specific-motor space. This can be seen from Wilks' Lambda with a value of .996, which with Rao's F approximation of .402, gives importance to the differences between the groups at the level Q (F) test = .670.

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

		Mean	MS Effect	MS Error	F	Q (Sig.)
SMLJG	Experimental	364.1	5.05	237.27	.0021	.9631
	Control	354.4				
SMTJ	Experimental	724.2	85.22	843.04	.5319	.4666
	Control	715.1				

From the inspection of table no.5, we have shown the results of the univariate analysis of variance (ANOVA) on the specific-motor variables, between the experimental group and the control, in the initial measurements. From the overview of arithmetic mean values, coefficient F and level of reliability Q (sig.) for each indicator individually, we have no statistically significant differences between the experimental group and control on specific motor skills.

Table 6. Multivariate analysis of covariance (MANCOVA) in specific-motor variables between the control and experimental group in the final measurements by neutralizing the differences with the initial measurements

Wilks' Lambda	Rao's R	df 1	df 2	Q
.972	3.080	2	217	.048*

In Table 6, we show the results of the multivariate analysis of covariance (MANCOVA) between the experimental group and the control, in the final measurements with partialization and neutralization of differences in mean values from the initial measurements, there are statistically significant differences between groups in the specific-motor space. This can be seen from Wilks' Lambda with a value of .972, which with

Rao's F approximation of 3.080, and with degrees of freedom df1 = 2 and df2 = 217, gives importance to the differences between the groups at level Q (F) test = .048. From this analysis the explosive force development program, applied in the experimental period, had a statistically significant impact on the process of transformation of specific motor skills in the experimental group compared to the control group.

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

		MEAN	F	Q (Sig.)
SMLJG	Experimental	447.0	3.766	.017*
	Control	371.0		
SMTJ	Experimental	745.5	2.614	.049*
	Control	722.2		

From the description of table 7, we have shown the results of the univariate analysis of covariance (ANCOVA), between the experimental group and control in the final measurements by partializing and neutralizing the differences of mean values from the initial measurements, in all specific-motor variables there are statistically significant differences (Q <.05), even in all tests in favor of the experimental group. The differences are both variables: the long jump gathering technique (SMLJG), (.017) and the triple jump (SMTJ). (.048). From this it can be concluded that the plyometric program applied for the development of explosive force, causes a quantitative improvement with statistical significance in the development of specific-motor tests in the subjects of the experimental group.

4. Discussion

After the implementation of the plyometric program for the development of explosive force, which training model lasted 12 weeks and underwent only the experimental group, from the examination of the final measurements, it was proved that in specific motor skills there are statistically significant differences in the two studied variables, where the results obtained were in favor of the experimental group compared to the control group. Herrero et al. (2006) by combining the plyometric program with the electrostimulation in 40 students in a period of 4 weeks, significantly improved the results in long jump and sprinter running's. Impellizzeri et al. (2008) tested a plyometric program on 37 footballers over a 4-week period, concluding that this training model improved results in long jump and sprinter runs. Bemito et al. (2013) applied combined training as well as plyometric and neuromuscular electrostimulation to the performance of triple jump and sprint running at 30 meters in 84 students aged 15-year-old over a period of 8 weeks, and at the end of the experiment concluded that this combined training model significantly improved of triple jump and sprint running at 30 m. Hermassi et al. (2014) reported that 8-week plyometric training has significantly improved lower limb strength and long jump performance, which program was applied during the competitive season to elite handball players under the age of 20. Elalem (2018) applied plyometric training in tartan and sand to the triple jump performance of 12 students of the Faculty of Physical Education at the University of Alexandria, and after applying the training program for three months, the results showed that plyometric training in tartan and sand significantly improved physical skills and biomechanical variables in triple jump, even that plyometric training in tartan improved the distance of triple jump by 6.61%, while in the sand by 5.92%. Asadi et al. (2018) tested the effect of plyometric training and the effects of maturity on strength performance and sprint running in young footballers. The authors concluded that short-term plyometric training had positive effects on sprinting and jumping, which are important determinants of action in football matches. Bogdanis et al. (2019), conducted a study in 50 high school students aged 7-9 years, where the experimental group implemented a plyometric program in a period of 8 weeks, where the authors concluded that plyometric training increased the performance in sprint and agility in favor of the experimental group, while long jump performance was improved equally in both groups. From the analysis of the results and discussions we can conclude that the 12-week plyometric program for the development of explosive force had a positive effect on improving the results in long jump and triple jump as specific motor skills in students, more specifically improved the results of all experimental group in all tests in the final measurements. From this experiment we can confirm that this type of plyometric program should also be a model for all pedagogues, coaches and sports researchers, who want to increase the performance of explosive force in long jump disciplines to students, and why not this type the program should be applied to elite athletes as well.

References

[1]. Antekolovič, Lj., Zufar, G. i Hofman, E. (2004). Metodika razvoj eksplozivne snage tipa skočnosti (Methodology of development of explosive power of jump type), Međunarodni naučno-stručni skup, Kondiciona priprema sportista, Zbornik radova. Zagreb : Fakultet za fizičku kulturu Sveučilišta u Zagrebu.

[2]. Arazi, H. et al. (2012). Comparative effect of land and aquatic based plyometric training on the jumping ability and agility of young basketball players. S Afr J Sport Phy Edu Rec., 34: 1-14.

[3]. Asadi, A. et al.(2018). The effect of maturation on jumping ability and sprint adaptations to plyometric training in youth soccer player. J. Sports Sci., 36 (21): 2405-2411.

[4]. Asllani, I. (2007). Uticaj eksplozivne snage na rezultatsku efisnost u daljinskim skokovima kod omladinaca (The impact of explosive power on the resultant efficiency in long-range jumps in youth). Doctoral dissertation: Faculty of Sport and Tourism- Novi Sad.

[5]. Asllani, I. (2016). Atletika (Athletics), ArbëriaDesign, Tetovë.

[6]. Benito, E. et al. (2013). Effect of combined electrostimulation and plyometric training on 30 meters dash and triple jump, The Journal of sports medicine and physical fitness, 54 (4): 387-395.

[7]. Bogdanis, C. G. et al. (2019). Effect of plyometric training on jumping, sprinting and change of direction speed in child female athletes, Sports (Basel), 7 (5): 116.

[8]. Chu, D. (1993). Jumping into plyometrics. VHS. Human Kinetics, Chapaign Il, USA.

[9]. De Villarreal, E.S.S., Kellis, E., Kraemer, W.J., & Izquierdo, M. (2009). Determining variables of plyometric training for improving vertical jump height performance: a meta-analysis. Journal of Strength and Conditioning Research, 23, 495-506.

[10]. Diallo, O. et al. (2001). Effects of plyometric training followed by a reduced training programme on physical performance in prepubescent soccer players. J Sports Med Phys Fitness. 41(3): 342-348.

[11]. Ebben, W.P., Feldmann, C.R., VanderZanden, T.L., Fauth, M.L., & Petushek, E.J. (2010). Periodized plyometric training is effective for women, and performance is not influenced by the length of post-training recovery. Journal of Strength and Conditioning Research, 24, 1-7.

[12]. Ebben, P. W. et al. (2014). The effect of plyometric training volume on jumping performance, 32nd International Conference of Biomechanics in Sports.

[13]. Elalem, S. F. (2018). The effect of plyometric exercises performance on tartan and sand on the technique and triple jump distance, The Scientific Journal of Physical Education and Sports Sciences, 84(9): 188-214.

[14]. Herrero JA, et al. (2006). Electromyostimulation and plyometric training effects on jumping and sprint time. Int J Sport Med. 27(7): 533-539. Doi:10.1055/5-2005-865845.

[15]. Hermasi, S. et al. (2014). Effects of a short-term in season plyometric training program repeated sprint ability, leg power and jump performance of elite handball players. International Journal of Sports Science & Coaching. 9(5): 1205-1216. https://doi.org/10.1260%2F1747-9541.9.5.1205.

[16]. Impellizeri, FM. et al. (2008). Effect of plyometric training on sand versus grass on muscle soreness and jumping and sprinting ability in soccer players. British Journal on Sports Medicine, 42: 42-46.

[17]. Iseni, A. (2016). Влијание на експлозивната сила врз ефикасноста на резултатите во спринтерските трчања кај ученици од 14-годишна возраст (Influence of explosive force on performance results in sprinter runs in 14-year-old students). Doctoral dissertation: Faculty of Physical Education, Sport and Health – Skopje.

[18]. Jakoljević, M. (2013). Efekti aplikativnog modela treninga snage na razvoj antropoloških dimenzije i rezultata u bacaćkim disciplinama (Effects an applied model of strength training on the development of anthropological dimensions and results in the throwing disciplines). Doctoral dissertation: Faculty of Physical Education and Sport – University of East Sarajevo.

[19]. Jensen, R.L., Flanagan, E.P. Jensen, N.L., & Ebben, W.P. (2008). Kinetic responses during variations in plyometric exercises. In: Proceedings of the XXVI Congress of the International Society of Biomechanics in Sports; Y.-H. Kwon, J. Shim, J. K. Shim and I.-S. Shin, (eds). p. 393-396.

[20]. Markovic, G. et al. (2007). Does plyometric training improve vertical jump height? A meta analysis review. Br J

Sports Med., 1(53): 349-355.
[21]. Meyers, R. W. et al. (2017). New insights into the development of maximal sprint speed performance in male youth, J. Strength and Cond. Research, 39, 2-10.
[22]. Michialidis, Y. et al. (2013). Plyometrics' trainability in preadolescent soccer player. J Strength Con Rresearch. 27(1): 38-49.
[23]. Milanović, D. (1981). Latentna struktura nekih testova za procjenu faktora eksplozivne snage (The latent structure of certain tests for the evaluation of explosive strength). Kineziologija, 12, 35-42.
[24]. Moran, J. et al. (2017). Maturation-releated effect of low-close plyometric training on performance in youth hockey players, Pediatr. Exerc. Sci., 29: 194-202. Doi: 10.1123/pes.2016-0151.
[25]. Potach, D. & Chu, D. (2000). Plyometric training. In: Essentials of strength training and conditioning (Second Edition). Editorss: T.R. Bachle and R.W. Earle, Champaign, Il, USA: Human Kinetics.
[26]. Radić, Z.& Simeonov, A. (2009). Влијанието на некои морфолошки и моторни фактори врз резултатот во трчањето на 100 метри (The influence of some morphological and motor factors on the result in running 100 meters), Physical education (Skopje), vol. 37, no. 2, pp. 158-160.
[27]. Ramirez-Campillo, R et al. (2014). Effects of in-season low-volume high-intensity plyometric training on explosive actions and endurance of young soccer players. J Strength Cond Research, 28(5): 1335-1342.
[28]. Ramirez–Campillo, R. et al. (2018). A methodological characteristics and future directions for plyometric jump training research: A scoping rewiev. Sport Medicine, 48, 1059-1081.