

EFFECTS OF PLYOMETRIC TRAINING ON BODY COMPOSITION AND MOTOR SKILLS IN FEMALE FOOTBALL PLAYERS

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Abstract. *This paper aims to determine the impact of plyometric training programs of short duration (6 weeks) and high frequency (3 times a week) on the motor skills and body composition of female football players. The total number of participants was 24 female football players, four of whom were excluded due to absence from the final testing (mean value of height 167.53 ± 6.09 ; and mean value of weight 58.32 ± 8.87). The sample of variables used in the study, to which all the participants were subjected, represents the assessment of body composition, explosive power of the lower extremities, speed, agility, and endurance assessment. The results of the research showed that the six-week program of specific plyometric training for Serbian Super League football players in the basic preparatory period of the season did not affect statistically significant changes in the monitored body composition parameters. Also, the statistically significant changes did not occur in the parameters of explosive power and speed, which was expected according to the age category and level of competition of the participants, which was confirmed by previous research. The changes that occurred with high statistical significance are changes in agility tests with and without a ball as well as in the parameters of cardiorespiratory endurance.*

Key words: *female football players, motor skills, plyometric training, body composition*

INTRODUCTION

In sports such as football, there are a large number of repetitions of activities that require high intensity, such as jumping, changing directions, changing the pace of running, kicking the ball, etc. (Stølen, Chamari, Castagna, & Wisløff, 2005). A large number of

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repetitions of high-intensity activity during the 90 minutes of a game requires a high degree of endurance and muscle strength (Stolen et al., 2005). Therefore, one of the most important tasks of the training process in football is the improvement of specific strength, which could be defined as the ability of players to use muscle strength effectively when performing tasks characteristic of a football match (Sporiš, Jovanovic, Krakan, & Fiorentini, 2011).

Several studies highlight the potential advantage of a training processes in which plyometric training is applied (Campo, et al., 2009; Ramirez-Campillo, et al., 2020). Numerous studies have shown that plyometric training leads to positive changes in the field of motor skills in football players (Mohd, et al., 2014; Beato, et al., 2018; Siegler, Gaskill, & Ruby, 2003; Campo, et al., 2009; Ramirez-Campillo, et al., 2016; Ramirez-Campillo, et al., 2020).

Ramirez-Campillo and colleagues (2018) found that plyometric training lasting eight weeks, regardless of frequency, but with the same intensity, has a positive effect on the explosive strength of the legs and endurance in amateurs who play football. Confirmation that the frequency of training is not crucial is obtained when we compare the research conducted by Ozbar and colleagues in 2014 and 2015, which shows that eight weeks of plyometric training (1 time per week) gives approximately equal improvements in assessment tests of explosive leg strength (improvement by 17%) as well as a ten-week training with twice the frequency (an improvement of 21%). Rubley (2011) showed that plyometric training in female football players for 7 weeks with low frequency (1 training per week) does not lead to an improvement in explosive power, while Ozbar and colleagues (2014) found that an eight-week program of the same frequency affects the improvement of explosive power football boots. Ramírez-Campillo and colleagues (2015) confirmed that plyometric training lasting 6 weeks (1 training per week) has a positive effect on the motor skills of female football players, while Chimera (2004) found that the program of the same duration and frequency does not cause statistically significant changes in motor skills. Ramirez-Campillo (2020) with a group of authors in a review study with a meta-analysis showed that the lowest frequency of plyometric training lasts for six weeks, and that it has a moderate impact on the parameters of jumping in female football players.

To our knowledge, in contrast to a large number of papers dealing with the impact of plyometric training on the motor skills of female football players (Mohd, et al., 2014; Beato, et al., 2018; Siegler, Gaskill, & Ruby, 2003; Campo, et al., 2009; Ramírez-Campillo, et al., 2016; Ramirez-Campillo, et al., 2020) there is a much smaller number of papers dealing with the impact of plyometric training on body composition (Campo, et al., 2009; da Silva, et al., 2017; Markovic, et al., 2005).

Campo showed his associates (2009) that a twelve-week training session does not have a significant effect on muscle mass, but that is why it has a large effect on the body fat of football players. Da Silva (2017) found that plyometric training lasting four weeks has a great effect on reducing body fat and increasing muscle mass in athletes who play football.

Based on our literature review, we can see that the results of tests that dealt with the impact of plyometric training on motor skills vary from study to study, and that the number of papers known to us that deal with the impact of plyometrics training on body composition is small. In most studies, the duration of the program is long (8-14 weeks), and the frequency is small (1-2 times a week). This paper aims to determine the impact of plyometric training programs of short duration (6 weeks) and high frequency (3 times a week) on the motor skills and body composition of female football players.

METHODS

The sample of participants

The sample of participants consisted of football players who play in the highest rank of competition, the Serbian Super League. The total number of participants was 24 female football players, four of whom were excluded due to absence from the final testing (mean height 167.53 ± 6.09 ; and mean weight 58.32 ± 8.87). The inclusion criteria were: injury-free in the last six months, underwent a medical examination, participants who managed to maintain training continuity without absences from training sessions. The exclusion criteria were: persons in the recovery phase from some form of acute and chronic injuries, persons in the process of rehabilitation, and football players who did not complete the training process.

All of the participants were first informed about the study, the purpose, goal, procedure, the course of the test and the possible consequences were explained to them. Before the research, each participant signed a consent form, and after that the testing began. The study was voluntary and each of the participants could withdraw from the study at any time during the testing.

The research was approved by the Ethics Committee of the Faculty of Sports and Physical Education, University of Nis in accordance with the Declaration of Helsinki.

Procedures

The sample of variables used in the study, to which all the participants were subjected, represents the assessment of body composition, explosive power of the lower extremities, speed, agility and endurance assessment. In the morning, before the test, the participants did not consume food and beverages. Due to technical reasons, i.e. the impossibility of transferring equipment, testing of the variables used to assess body composition and explosive power of the lower extremities was done indoors, in the room where the instruments are located. The power assessment tests were preceded by a standardized warm-up that included moderate-intensity running (5 min), and static and dynamic stretching (5 min). Field tests used to assess speed, agility, and endurance were preceded by a 15-minute warm-up, a 10-minute run and dynamic warm-up, and a 5-minute dynamic stretch. The same protocol was applied in both the initial and final testing.

The assessment of body composition and strength was determined in the morning (10 am). It included the assessment variables of body height (cm), body weight (kg), while body fat, lean body mass, muscle mass, segmental analysis of the right and left legs were measured in absolute and relative values. Also, the results of the body mass index (BMI) were noted. Body height was measured using a portable anthropometer (Seca 220, Seca Corporation, Hamburg, Germany) with an accuracy of 0.1 cm. Other body composition values were obtained using InBody 770 (Aandstad, Holtberget, Hageberg, Holme, & Anderssen, 2014). The percentage of muscle mass was obtained using the formula $MM\% = MM \text{ kg} / \text{body weight (kg)}$. The percentage of lean body mass was obtained using the formula $NTM\% = NTM \text{ kg} / \text{body weight (kg)}$.

The tests used to assess the explosive power of the lower extremities are: the countermovement jump (CMJ), countermovement jump with free arms (CMJA), and squat jumps (SJ).

The *countermovement jump test* was measured using Optojump (Glatthorn et al. 2011). Jump values were obtained by placing the participant in a confined space encompassed by

Optojump sensors. From an upright position, on the invigilator's signal, the participant with hands on hips, goes into a half-squat and from that position jumps as high as possible. If the participant makes a mistake during the performance, the performance is repeated. It was necessary for the participant to perform three technically correct jumps. The best result was taken for analysis.

The *countermovement jump with free arms* is a test that also assesses the explosive power of the lower extremities, only differing in that in this test the hands are free next to the body. It was necessary for the participant to perform three technically correct jumps. The best result was taken for analysis. It was also measured using the Optojump sensor (Glatthorn et al. 2011). The squat jumps test was performed by the participant assuming the starting position in a half squat with hands on hips. At the sign of the invigilator, the participant takes off from the starting position in a vertical jump. Each test was repeated three times, and the best achieved values were taken for analysis. Jump values are displayed on the screen using Optojump sensors (Glatthorn et al. 2011).

Sprint speed at 10m, 20m, 30m

The participant starts from a high start at the moment when she assesses that she is ready and sprints across the entire 30m track with a passing time of 10m, 20m and 30m (Delextat & Cohen, 2009).

The T-test

The participants had the task of crossing the path between the four bases (A, B, C and D) set in the shape of the letter T in the shortest possible time. The total distance traveled was 40 meters, and the time measurement began and ended at base A. From the start line, the participant runs as fast as she can straight ahead - to base B and touches the base with her right hand, then turns left and runs to base C (touches the base with her left hand), then turns and runs to base D (touches the base with her right hand), turns and runs back towards cone B touches the base on her left hand, turns left and runs to the goal (base A) (Paule, Madole, Garhammer, Lacourse & Rozenek, 2000).

The „505“ running test

The participants had the task of crossing the distance between markers 15 m apart in the shortest possible time. The participants tried to achieve maximum acceleration from the starting line to, and then to stop the curves of the second marker, turn 180° and run again, maximally accelerating the valleys to the finish (5 m). The total previous path in this task is 20 meters (Draper & Lancaster, 1985).

The 9-6-3-6-9 test with a 180° turn

It is used to estimate the speed of changing direction of movement with the given rotations around the axis of the body by 180°, with an emphasis on frontal agility. The participant assumes a high start position so that her chest is facing the goal. At the invigilator's signal, she starts running at maximum speed to the line 9m away from the start, touches the line with her foot, turns 180° and continues running (chest turned towards the starting line) to the line 6m away from the start. She touches the line again, turns a second time and continues running to the line 12 m from the start. She touches the line once more,

turns for a third time for 180° and continues to run to the line 9 m away from the start. On that line, for the fourth time, she changes the direction of movement by 180°. The task is completed when the participant, running at maximum speed, passes the imaginary finish line with her chest (18 m away from the start). (Sporis, Jukic, Milanovic & Vucetic, 2010).

The 4x5m sprint

The test consisted of a constant change of direction that the players had to perform. Five bases were placed at a distance of 5 m. The participants stood feet apart and with the bases between their legs. Each player started after the beep and ran 5 m from point A to point B. After reaching point B, she turned 90 degrees to the right and then moved 5 m to point C. At point C, she made a 90° turn and ran to point D, where she turned 180° and ran overtaking E (finish line). The same test was repeated with a ball. (Sporis, Jukic, Milanovic & Vucetic, 2010).

Yo-yo Intermittent Recovery Test 2

The test is used to assess the rate of recovery during intense acyclic activity of an aerobic-anaerobic character. At the sound signal from a CD player, all players run to a cone 20 m away (mark B) and back to the start. Upon arrival at the start, the participants have a 10-second break during which they must run slowly to a third cone (mark C) 5 m away and return. At a new signal, the running is repeated. Running speed increases progressively. The test is interrupted when the participant fails to run the section twice in a row, at the set speed. The result of the test is the total run section in meters (Bangsbo, Iaia & Krstrup, 2008)




Running without and with a ball is used to assess the agility and skill of running with a ball. The participant from the high start position, after a visual signal, has the task of running the set zigzag track with a total length of 20 m as fast as possible. The participant occupies the same position as in the previous case, but with a soccer ball next to the foot that is closer to the starting line. She repeats the previous task, this time leading the ball (Little & Williams, 2005; Mirkov, Nedeljkovic, Kukolj, Ugarkovic & Jaric, 2008).

Experimental treatment

The participants were exposed to six weeks of plyometric training (Table 1). Although all the football players had previous experience in this type of training, the training instructor gave instructions and practically demonstrated the manner and technique of performing each exercise before each training. Plyometric training was held after 15 minutes of warm-up at the beginning of the training, three days a week.

Part of the plyometric training lasted 40-45 minutes after training, and the training regime was based on three different exercises. Exercise 1 and Exercise 2 were done in 4 series with a break between series of 30 seconds and a break between exercises of 40 seconds. Exercise 3 was done in two series and with a break of 4 minutes between series.

Table 1 Plyometric training program

Number per week	Number for six weeks	Exercise	Monday	Wednesday	Friday
			Warm up: 15` Plyometric training: 40-45`	Warm up: 15` Plyometric training: 40-45`	Warm up: 15` Plyometric training: 40-45`
15	90		<i>Exercise 1:</i> A series of 5 jumps over obstacles of 50 cm high, the distance between the obstacles is 45 cm.	<i>Exercise 1:</i> A series of 5 jumps over obstacles of 50 cm high, the distance between the obstacles is 45 cm.	<i>Exercise 1:</i> A series of 5 jumps over obstacles of 50 cm height, the distance between the obstacles is 45 cm.
15	90		<i>Exercise 2:</i> A series of 5 jumps, sun jumps, over an obstacle 20 cm high, the distance between the obstacles is 30 cm.	<i>Exercise 2:</i> A series of 5 jumps, sun jumps, over an obstacle 20 cm high, the distance between the obstacles is 30 cm.	<i>Exercise 2:</i> Series of 5 jumps, sun jumps, over an obstacle of 20 cm height, distance between obstacles is 30 cm
36	216		<i>Exercise 3:</i> A series of 12 jumps on a box 40 cm high.	<i>Exercise 3:</i> A series of 12 jumps on a box 40 cm high.	<i>Exercise 3:</i> A series of 12 jumps on a box 40 cm high
			The main part: 35-40` TE/TA exercise	The main part: 45` Play in a shortened space	The main part: 25-30` TA exercise

Legend: TE - technique exercises; TA - tactical exercises

Statistical data processing

For data processing and analysis, the statistical package for data processing SPSS 20 was used (IBM Corporation; Armonk, NY, USA). The Kolmogorov-Smirnov test was performed first to examine the normality of the distribution of results. The basic parameters of descriptive statistics for each variable were calculated. The basic descriptive parameters were: arithmetic mean (Mean), standard deviation (Std.Dev.), minimum value (Min), maximum value (Max). To determine the differences, we used a two-way ANOVA (group x time) with repeated measurements. Also, an effect size was done to determine the magnitude of the impact.

3. RESULTS

Based on the results presented in table 2, which describes the differences between the initial and final measurements within the variables describing the body composition of the participants, it can be seen from the statistical analysis of the repeated-measures T-test that there is no statistically significant difference between the values at the initial and

final measurements in almost any of the variables. The analysis that calculates the effect size also did not show a greater impact in any variable other than the trivial.

Table 2 The differences between the parameters of body composition at the initial and final measurement

Variables	I (M ± SD)	F (M ± SD)	P	Cohen Effect Size ES (95% CI)
IH(cm) – FH(cm)	167.53 ± 6.09	167.68 ± 6.16	.083	-0.03 (-0.66 to 0.61) ^T
IW(kg) – FW(kg)	58.32 ± 8.87	58.68 ± 8.81	.227	-0.04 (-0.68 to 0.60) ^T
IBMI - FBMI	20.84 ± 2.41	20.83 ± 2.33	.920	0.00 (-0.63 to 0.64) ^T
IFMkg(kg) – FFMkg(kg)	12.43 ± 4.35	12.62 ± 4.33	.483	-0.04 (-0.68 to 0.59) ^T
IFMp(%) – FFMp(%)	20.90 ± 5.10	21.22 ± 5.24	.466	-0.06 (-0.70 to 0.58) ^T
ILBMkg(kg) – FLBMkg(kg)	45.62 ± 4.63	46.07 ± 5.91	.402	-0.09 (-0.72 to 0.55) ^T
ILBMp(%) – FLBMp(%)	78.93 ± 6.21	78.79 ± 5.23	.889	0.02 (-0.61 to 0.66) ^T
IMMkg(kg) – FMMkg(kg)	25.32 ± 3.47	25.41 ± 3.49	.401	-0.03 (-0.66 to 0.61) ^T
IMMp(%) – FMMp(%)	43.61 ± 2.87	43.42 ± 2.90	.373	0.07 (-0.57 to 0.70) ^T
ISARLkg(kg) – FSARLkg(kg)	7.3 ± 0.96	7.46 ± 1.01	.140	-0.07 (-0.70 to 0.57) ^T
ISARLp(%) – FSARLp(%)	112.93 ± 6.16	112.84 ± 6.61	.911	0.01 (-0.62 to 0.65) ^T
ISALLkg(kg) – FSALLkg(kg)	7.30 ± 0.94	7.37 ± 0.98	.068	-0.08 (-0.71 to 0.56) ^T
ISALLp(%) – FSALLp(%)	111.54 ± 6.52	111.77 ± 6.46	.684	-0.04 (-0.67 to 0.60) ^T

Legend: N - Number of participants; cm - centimeters; kg - kilograms; % - percentage; IH - Height of the participants at the initial measurement; IW - Weight of the participants at the initial measurement; IBMI - Body Mass Index at the initial measurement; IFMkg - Body fat in kilograms at the initial measurement; IFMp - Body fat percentage at the initial measurement; ILBMkg - Lean body mass in kilograms at the initial measurement; ILBMp - Lean body mass percentage at the initial measurement; IMMkg - Muscle mass in kilograms at the initial measurement; IMMp - Muscle mass percentage; ISARLkg - Segmental analysis of the right leg in kilograms at the initial measurement; ISARLp - Segmental analysis of the right leg in percentages at the initial measurement; ISALLkg - Segmental analysis of the left leg in kilograms at the initial measurement; ISALLp - Segmental analysis of the left leg in percentages at the initial measurement; FH - Height of the participants at the final measurement; FW - Weight of the participants at the final measurement; FBMI - Body Mass Index at the final measurement; FFMkg - Body fat in kilograms at the final measurement; FFMp - Body fat percentage at the final measurement; FLBMkg - Lean body mass in kilograms at the final measurement; FLBMp - Non-fat body mass percentage at the final measurement; FMMkg - Muscle body mass in kilograms at the final measurement; FMMp - Muscle body mass percentage at the final measurement; FSARLkg - Segmental analysis of the right leg in kilograms at the final measurement; FSARLp - Segmental analysis of the right leg in percentages at the final measurement; FSALLkg - Segmental analysis of the left leg in kilograms at the final measurement; FSALLp - Segmental analysis of the left leg in percentages at the final measurement; p - Statistical significance of the difference between the initial and final measurement; I - Initial measurement; F - Final measurement; M - Mean value; SD - deviation from the mean value, ES = effect size; CI = confidence interval, T - Trivial, <0.2.

Based on the results presented in table 3, which describes the differences between the initial and final measurement within the variables describing the motor space, it can be seen that there is a statistically significant difference between the initial and final measurement of the participants. A statistically significant difference determined by the repeated-measures T-test was found for the variables: CMJa ($r = 0.00$), while the analysis of the effect size showed a small effect size (-0.57 (-1.20 to 0.09)); 505 ($r = 0.00$), a very large effect size (3.74 (2.62 to 4.70)); 96369 ($r = 0.03$), a small effect size (-0.44) (-1.07 to 0.21)); T test ($r = 0.00$), a medium effect size (0.84 (0.16 to 1.48)); CIKCAK ($r = 0.00$), a medium effect size (0.85 (0.17 to 1.50)); CYCLE ($r = 0.00$), a medium effect size (0.99 (0.29 to 1.64)); YOYOd ($r = 0.00$), a large effect size (-1.52 (-2.21 to -0.77)); VO2MAX (ml / min / kg) ($r = 0.00$), and a large effect size (-1.60 (-2.30 to -0.84) There were no

statistically significant differences between the initial and final measurements in the other variables at the final measurement for the motor abilities.

Table 3 Difference between the parameters of motor abilities at the initial and final measurement

Variables	I (M ± SD)	F (M ± SD)	P	Cohen Effect Size ES (95% CI)
ICMJ(cm)–FCMJ(cm)	23.88 ± 3.28	24.77 ± 3.15	0.09	-0.28 (-0.91 to 0.37) ^M
ICMJa(cm)–FCMJa(cm)	26.79 ± 4.00	28.98 ± 3.73	0.00	-0.57 (-1.20 to 0.09) ^M
ISJ(cm)–FSJ(cm)	22.29 ± 2.85	22.97 ± 2.85	0.24	-0.24 (-0.87 to 0.40) ^M
IS10m(s)–FS10m(s)	2.02 ± 0.09	2.04 ± 0.22	0.70	-0.12 (-0.76 to 0.52) ^T
IS20m(s)–FS20m(s)	3.53 ± 0.14	3.57 ± 0.15	0.46	-0.27 (-0.90 to 0.38) ^M
IS30m(s)–FS30m(s)	4.97 ± 0.21	5.05 ± 0.35	0.19	-0.29 (-0.92 to 0.36) ^M
I505(s) - F505(s)	4.65 ± 0.20	3.94 ± 0.18	0.00	3.74 (2.62 to 4.70) ^{VV}
I96369(s) - F96369(s)	8.03 ± 0.43	8.23 ± 0.47	0.03	-0.44 (-1.07 to 0.21) ^M
ITtest(s)– FTtest(s)	10.97 ± 0.40	10.65 ± 0.35	0.00	0.84 (0.16 to 1.48) ^U
ICIKCAK(s)– FCIKCAK(s)	5.76 ± 0.24	5.56 ± 0.22	0.00	0.85 (0.17 to 1.50) ^U
ICIKCAKL(s)– FCIKCAKL(s)	7.85 ± 0.55	7.29 ± 0.59	0.00	0.99 (0.29 to 1.64) ^U
I4X5M(s) - F4X5M(s)	6.21 ± 0.27	6.29 ± 0.20	0.19	-0.33 (-0.96 to 0.32) ^M
I4X5ML(s) - F4X5ML(s)	8.19 ± 0.62	8.11 ± 0.55	0.55	0.14 (-0.50 to 0.78) ^T
IYOYOd(m)– FYOYOd(m)	1272.11±364.40	1885.26±437.56	0.00	-1.52 (-2.21 to -0.77) ^V
IVO2MAX(ml/min/kg) – FVO2MAX(ml/min/kg)	47.01 ± 2.98	52.39 ± 3.71	0.00	-1.60 (-2.30 to -0.84) ^V

Legend: N - Number of respondents; m. Meter; cm - Centimeter; s - Seconds; kg - Kilogram; min - Minute; ml - Mol; ICMJ - Vertical jump with a swing on the initial measurement; ICMJa - Vertical jump with a swing and free hands on the initial measurement; ISJ - Vertical squat jump on initial measurement; IS10m - Running speed at 10 meters at the initial measurement; IS20m - Running speed at 20 meters on the initial measurement; IS30m - Running speed at 30 meters at the initial measurement; I505 - 505 agility test on initial measurement; I96369 - Agility test 9-6-3-6-9 on initial measurement; ITtest - T test on initial measurement; ICIKCAK - CIKCAK test on initial measurement; ICIKCAKL - Test ZIKCAKL with a ball on the initial measurement; I4X5M - 4x5 meter test on initial measurement; ; I4X5ML - 4x5 meter test with ball on initial measurement; IYOYOd - Test YOYO length run on initial measurement; IVO2MAX - Maximum oxygen consumption at initial measurement; FCMJ - Vertical rocking jump on the final measurement; FCMJa - Vertical jump with a swing and free hands on the final measurement; FSJ - Vertical squat jump on the final measurement; FS10m - Running speed at 10 meters on the final measurement; FS20m - Running speed at 20 meters on the final measurement; FS30m - Speed of running at 30 meters on the final measurement; F505 - 505 agility test on final measurement; F96369 - Agility test 9-6-3-6-9 on final measurement; FTtest - T test on the final measurement; FCIKCAK - CIKCAK test on the final measurement; FCIKCAKL - Test ZIKCAKL with the ball on the final measurement; F4X5M - 4x5 meter test on the final measurement; F4X5ML - 4x5 meter test with ball on final measurement; FYOYOd - Test YOYO length run on the final measurement; FVO2MAX - Maximum oxygen consumption at the final measurement; p - Statistical significance of the difference between the initial and final measurement; I - Initial measurement; F - Final measurement; M - Mean value; SD - deviation from the mean value; ES = effect size; CI = confidence interval, T - Trivial, <0.2; M - Small, 0.2–0.59; U - Moderate, 0.6–1.19; V - Great, 1.2–1.99; VV - Very large, >2.

DISCUSSION

The results obtained in this study indicate that plyometric training lasting 6 weeks, three days a week does not significantly affect the body composition of the participants. The same result was obtained in one of the previous studies analyzed in this paper (Campo, et al., 2009). In that research, the participants were also football players, with

the difference that their plyometric training program lasted twice as long, but there was also no statistically significant effect of plyometric training on body composition.

Plyometric training has been recommended as a good alternative to strength training for the lower extremities (Myer, Ford, Palumbo, & Hewett, 2005). It is very often applied in the preparatory period in order to bring the players into a satisfactory form. Such work in the preparatory period can lead to an improved performance of football players, such as increasing muscle strength and endurance.

It has been found that programs applied three times a week for six to ten weeks have a better effect compared to other plyometric training programs (Ozbar, Ates, & Agopyan, 2014). Although the program applied in this study was within the recommended values, i.e. it was applied three times a week for 6 weeks, not all the tests achieved the desired effect. Specifically, no significant difference between the initial and final measurements was observed in the speed estimation tests.

Speed as a motor ability is very important skill in football. High-speed players have an advantage over others when it comes to getting the ball or taking the ball away from the opponent. Plyometric training has been marked as adequate for speed development in a review of previous works (De Villarreal, Requena, & Cronin, 2012). Nevertheless, the participants did not achieve significantly better results at the final measurement after the applied training program on the tests for determining the speed of S10, S20 and S30, which further implies that plyometric training in this case did not affect speed. The results obtained differ from the results in some previous studies (Beato, et al., 2018; Fischetti, Cataldi, & Greco, 2019), there are studies in which speed also did not improve significantly after plyometric training (Jeong, 2005; Lee, Ha, Ju, & Lee, 2019).

However, when it comes to motor skills tests, the research showed that the training program had an impact on the results of certain tests. The obtained results indicate that plyometric training had a statistically small effect on the results of the CMJ test. As the CMJ test is used to evaluate the explosive strength of the legs, it can be concluded that plyometric training has a positive effect on the explosive strength of the legs, i.e. muscle strength, and at the same time on the football players' jumping abilities. Such results have been obtained in some other studies (Mohd, Kamaruzaman, Syed Ali, & Kamar, 2014; Beato, et al., 2018; Chimera, Swanik, Swanik, & Straub, 2004).

An effect of plyometric training on the 505, T-test, and 96369 test was also observed. All of these tests are used to determine agility. As agility is defined as a combination of speed and explosive power, we can conclude that plyometric training affects the development of speed and explosive power in female football players. This resulted in better results on agility tests after 6 weeks of applied training. Beato and his associates (2018) also showed that plyometric training has a positive effect on the development of agility. Fischetti (2019) used the T-test to assess agility and obtained results that indicated that plyometric training had a positive effect on test results.

On the CIKCAK and CIKCAKL tests, better results were also achieved at the final measurement compared to those at the initial measurement. These two tests, in addition to assessing the agility of the participants, were also used to determine the level of the specific football technique in football players. Based on the results obtained, we can conclude that plyometric training after 6 weeks had a positive impact on the level of the specific football technique. The results obtained indicate that plyometric training fulfills one of the most important tasks of the training process of football players, and that is the improvement of specific strength (Bangsbo, 1994).

The results obtained showed that the plyometric training for a period of 6 weeks also had an impact on the endurance of a female football players, i.e. the effect size analysis observed large effects for the YOYOD and VO2MAX tests. Previous research analyzed in this paper studied the effects of plyometric training with regular training sessions 2 times a week for six weeks on endurance (Ramírez-Campillo et al., 2015). The results obtained also showed that plyometric training has a positive effect on the endurance of the participants.

CONCLUSION

The results of the research showed that a six-week program of specific plyometric training for Serbian Super League football players during the basic preparatory period of the season did not affect statistically significant changes in the studied body composition parameters. Also, statistically significant changes did not occur in the parameters of explosive power and speed, which was expected based on the age category and level of competition of the participants, and confirmed by previous research. The changes that occurred with high statistical significance are changes in agility tests with and without a ball, as well as in the parameters of cardiorespiratory endurance. In line with the obtained results, this study will certainly be useful for coaches and football players in the senior category in an attempt to determine the optimal strategy for increasing training for the basic preparatory period of the season.

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EFEKTI PLIOMETRIJSKOG TRENINGA NA TELESNU KOMPOZICIJU I MOTORIČKE VEŠTINE FUDBALERKI

Cilj ovog rada bio je utvrditi efekte kratkotrajnog (6 nedelja) i visoko frekventnog (3 puta nedeljno) pliometrijskog treninga na motoričke sposobnosti i telesnu kompoziciju fudbalerki. Ukupan broj ispitanica u ovoj studiji bio je 24, od kojih su četiri isključene zbog izostanka sa finalnog testiranja (srednja vrednost visine 167.53 ± 6.09 ; srednja vrednost težine 58.32 ± 8.87). Uzorak varijabli korišćenih u istraživanju, kom si pristupile sve ispitanice, predstavlja procenu telesne građe, eksplozivne snage donjih ekstremiteta, brzine, agilnosti i izdržljivosti. Rezultati istraživanja su pokazali da šestonedeljni program specifičnog pliometrijskog treninga za fudbalerke Superlige Srbije u pripremnom periodu sezone nije uticao na statistički značajne promene praćenih parametara telesne kompozicije. Takođe, nisu se desile statistički značajne promene u parametrima eksplozivne snage i brzine, što je bilo očekivano prema starosnoj kategoriji i stepenu takmičenja ispitanica, što je potvrđeno prethodnim istraživanjem. Promene koje su se desile sa visokim statističkim značajem su promene u testovima agilnosti sa i bez lopte, kao i u parametrima kardiorespiratorne izdržljivosti.

Ključne reči: fudbal, motorika, pliometrija, telesni sastav