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Application of Unilateral and Bilateral Plyometric Exercises on the Ability of Planned Agility and Acceleration; Effectis in Young Soccer Players

Emin Mujezinović[1], Fuad Babajić[1], Edin Užičanin[1], Vladimir Pavlinović[2], Šime Veršić[2]

[1]University of Tuzla, Faculty of Physical Education and Sport, Tuzla, Bosnia and Herzegovina, [2]University of Split, Faculty of Kinesiology, Split, Croatia

Abstract

The main aim of the study was to determine the difference in the effects between the two applied protocols (Unilateral and Bilateral), on the ability of planned agility and acceleration. For this research, the sample were active soccer players (N=30; 14 years in average). Two equal groups were formed randomly, unilateral group (EG=15) and bilateral group (CG=15). The study included an 8-week intervention of unilateral and bilateral plyometric training, applied as an integral part of soccer training, with three training sessions in one week. Both applied protocols were equalized according to the total load volume, the number of foot contacts with the ground and the character of the jump performance. Variables included tests of planned agility (side step test, and 505 test, arrowhead test), and acceleration tests (5- and 20 meters sprint). T-test for independent samples, and combined analysis of variance (2x2 / time x group) were calculated. The results showed no differences between the treatment groups, but absolute effects were achieved in both groups. The sidestep test, 505 planned agility test, arrowhead test, and 5 and 20-meter sprint test improved equally in both groups ($p<0.05$). In conclusion, unilateral and bilateral plyometric training lasting eight weeks led to significant improvements (pre/post= $p<0.05$) in sprint-type explosive power (acceleration ability) and preplanned agility, but without statistically significant differences in the magnitude of the effects between training groups.

Keywords: *football, conditioning capacity, power, speed, training effects*

Introduction

Soccer is a high-intensity, intermittent sport that requires players to have well-developed abilities to sprint, change direction, jump, and perform repeated duels during a match (Turner & Stewart, 2014; Wagner et al., 2023). Data from the analysis of movement during a soccer match showed that elite soccer players cover an average of 10-11 km, can jump up to 15 times and change direction 1200-1400 times in one match (Bangsboo, 1992; Rampini et al., 2007). Many of these intermittent actions are high-intensity in nature, and it stands to reason that strength and power training serve as useful training methods for soccer players to prepare for the demanding actions of the game of soccer. The capacity to perform fast and explosive movements has a high impact on the quality of performance during the match (Christopher et al., 2016, Mohr et al., 2003, Zamparo et al., 2015).

On the other hand, plyometrics is one of the standard methods that is often used in the development of speed-explosive qualities of athletes in different sports, especially in sports that require a high degree of speed and strength (Idrizovic et al., 2018; Kalata et al., 2023; Ozen et al., 2020). Given that the soccer game contains a large number of short, high-intensity activities, it can be concluded that plyometric training is a valuable training method for improving important motor skills in soccer players (Jaksic et al., 2023). In the physiological background of plyometric training is the cycle of muscle stretching and shortening (Turner & Jeffreys, 2010). According to the very definition, plyometrics include exercises whose goal is to connect the strength and speed of movement to achieve an explosive-reactive movement that will be mani-

Correspondence:

Šime Veršić
University of Split, Faculty of Kinesiology, Teslina 6, 21000 Split, Croatia
E-mail: simeversic@gmail.com

fested in movement activity. Numerous studies performed on soccer players showed that plyometric training significantly improves explosive strength and agility among soccer players (Bedoya, Miltenberger, & Lopez, 2015). Moreover, studies reported enhanced performance in sprinting speed and jumping height among players who engaged in regular plyometric routines (Bedoya et al., 2015).

Considering the above, it could be assumed that both modalities, which include the application of bilateral and unilateral content, can improve sports performance. However, there are still debates and an evident lack of research about the magnitude of the effects achieved by the application of these two modalities. Therefore, the main aim of this study was to determine whether one plyometric training modality is more efficient than the other. More precisely, this study aimed to gain information on how the ability of soccer players to accelerate, change the direction of movement, or jump can be improved with both unilateral and bilateral types of plyometric exercises.

Methods

Participants

This study involved a squad of young soccer players (N=30), 14 years old on average. Players train regularly for a long time in the Football Club „Sloboda" from Tuzla, Bosnia and Herzegovina, which competes at the highest national competitive level. None of the participants of the selected sample reported any chronic diseases, nor did they have medically contraindicated conditions, which are closely and specifically related to the implementation of training and diagnostic procedures. The fitness trainers of the club were informed about the nature and type of the experimental procedure and were instructed not to conduct any additional fitness training during the duration of this study. In this way, it was ensured that the achieved effects for both groups at the end of the experimental procedure can be explained solely by the application of the implemented programs. Before the implementation of the plyometric program, the subjects worked for 15 days on the physiological adaptation of the locomotor system in the fitness center with exercises that included mechanics of jumping and landing, strength development and joint stability.

Procedures and variables

Unilateral and bilateral plyometric training was applied as an integral part of technical-tactical soccer training, and conducted for 10 weeks (two weeks of physiological adaptation and 8 weeks of plyometric program), with three training units during one week. Bilateral protocol implied the application of bilateral contents (i.e. both leg jumps) while unilateral protocol consisted of unilateral plyometric contents (i.e. single leg jumps). Both applied protocols were equalized according to the total volume of the load, the number of contacts with the ground, the character of the performance of the jumps concerning the direction and plane in which they are performed, and the training period in which the contents were performed.

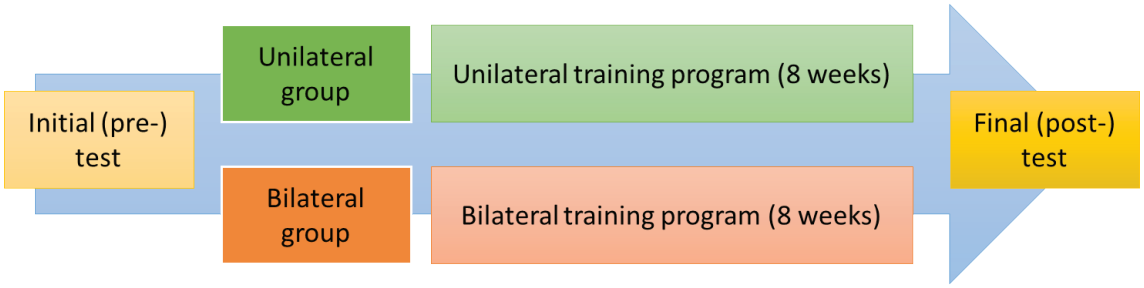

FIGURE 1. Conventional stress test

Initial testing was done 48 hours before the start of the plyometric exercise program. Two equal groups were formed after the test and based on the results. After a standardized warm-up protocol and specific preparation for performing plyometric exercises, the participants of each group performed prescribed plyometric training.

Observed variables consisted of a battery of agility tests that included the Arrowhead Agility Test performed on both sides (ARROW L and ARROW R), Steps to the side test (SS), and 505 Agility Test (A505). Also, acceleration and speed were tested with the sprint on 5 (S5) and 20 (S20) meters.

In the ARROW the participant starts from the high start position with his foot behind the starting line. At the sign from the examiner, the participant runs behind the stand in the middle at a distance of 10 meters, runs right or left to the next stand 5 meters away, and cuts diagonally inward to the final stand 15 meters from the starting line and back to the starting position. In the SS test participants must move laterally between two parallel lines, 1 meter long and 4 meters apart, as quickly as possible without crossing their legs. The test is complete when the participant has crossed the distance of 4 meters six times in this manner. A505 test is performed so that the participant runs 15 meters, turns around at the 15-meter mark, and runs back to the 10-meter mark. The time recorded is from passing the 10-meter gate to returning to the 10-meter gate, with a turn on the 15-meter line. Finally, 5 and 20-meter sprints were performed from the high starting position and participants had to cover the distance as fast as possible. For all the tests, the measurers used Brower Timing System devices (Draper, UT, USA) to read the results.

Statistics

The normality of the distributions was determined using the Kolmogorov-Smirnov test, and descriptive statistic parameters (arithmetic means and standard deviations) were calculated for all variables. An independent samples t-test was used to determine the existence of initial differences between treatment groups, while the differences before and after treatments within the groups were determined using the t-test of paired samples for each group individually. Finally, a combined analysis of variance (2x2 / time x group) was used to determine the differences in the treatments. Statistica 13.0 (TIBCO Software Inc, USA) was used for all calculations with a p-level of 95%.

Results

Mean values and standard deviations of all participants in both groups in observed variables in initial and final test-

Table 1. Descriptive statistics and T-test

Variables	Bilateral group (BIL)					Unilateral group (UNI)				
	Initial		Final		Effects	Initial		Final		Effects
	MEAN	SD	MEAN	SD	pre-post	MEAN	SD	MEAN	SD	pre-post
S5M	1.40	0.17	1.26	0.06	9.9%*	1.37	0.13	1.26	0.06	8.02%*
S20M	3.83	0.26	3.56	0.17	7.04%*	3.87	0.25	3.58	0.18	7.49%*
A505	3.05	0.17	2.42	0.16	20.6%*	3.01	0.26	2.36	0.13	21%*
SS	8.76	0.49	7.93	0.38	9.47%*	8.59	0.36	7.83	0.47	8.84%*
ARROW(L)	9.15	0.45	8.75	0.36	4.87%*	9.29	0.56	8.67	0.47	6.67%*
ARROW(R)	8.78	0.43	8.65	0.39	1.48%*	8.94	0.49	8.62	0.46	3.57%*

Note. S5M – sprint on 5 meters; S20M – sprint on 20 meters; A505 – agility 505 test; SS – side step test; ARROW(L) – Arrow agility test on the left side; ARROW(D) – Arrow agility test on the right side.

ing can be seen in Table 1. Also, the T-test for the analysis of differences between the initial and final state for both groups and indirectly calculated sizes of realized effects by group (%) are presented in Table 1. Results suggest statistically significant differences in all parameters for both groups.

Table 2. shows the results of the 2x2 mixed ANOVA where significant differences can be seen for all variables for the Time factor, but no statistically significant differences for the interaction of the factor (group x time). Results suggest that improvements occurred for all participants after the treatment but with no different effect between each group.

Table 2. Analysis of Variance (2x2 Mixed ANOVA)

Variables	Group			Time			Group x time		
	F	p	η^2	F	p	η^2	F	p	η^2
S5M	0.216	0.646	0.008	20.049	0.001	0.417	0.215	0.645	0.008
S20M	0.195	0.662	0.007	58.674	0.001	0.677	0.090	0.767	0.003
A505	0.602	0.444	0.021	368.157	0.001	0.929	0.073	0.789	0.003
SS	0.904	0.350	0.031	119.657	0.001	0.810	0.602	0.444	0.021
ARROW (L)	0.041	0.840	0.001	52.045	0.001	0.650	2.740	0.109	0.089
ARROW (R)	0.230	0.636	0.008	8.198	0.008	0.226	1.370	0.252	0.047

Note. S5M – sprint 5 meters; S20M – sprint 20 meters; A505 – agility 505 test; SS – side step test; ARROW(L) – Arrow agility test on the left side; ARROW(D) – Arrow agility test on the right side; F – F value for ANOVA; p – statistical significance, η2 – effect size

Discussion

This study aimed to determine the effects of the different plyometric training modalities on agility and acceleration performance among soccer players. Accordingly, two major findings can be highlighted. Firstly, the improvement after the intervention was noted for both groups in all observed variables. Also, there were no significant differences between the effects of treatment for both groups which suggests both types of training provoked similar adaptations.

Both unilateral and bilateral groups had significantly better results after 10 weeks treatment of plyometric training. Plyometric training, which involves explosive exercises that utilize the stretch-shorten cycle, has been consistently shown to improve agility and acceleration in athletes and is generally recognized as one of the most efficient methods for the development of explosive-speed capacities (Čaprić et al., 2022). The significant improvements observed in this study align with existing research. For example, a study on twenty-one youth soccer players showed that even short-term protocols are important and able to give meaningful improvements on power and speed parameters in a specific soccer population (Beato, Bianchi, Coratella, Merlini, & Drust, 2018). Similar findings were found in other sports and other samples. For example, a study on a youth female handball players showed that plyometrics performed two times per week for 10 weeks enhances measures related to game performance, such as change of direction, jump ability, reactive strength index, and power (Gaamouri et al., 2023).

The results of two-factor ANOVA indicate there were no differences in the magnitude of effects between the two groups. More precisely, regardless of whether the players performed unilateral or bilateral type of plyometric training, they enhanced agility and acceleration capacities in similar magnitude. The achieved results are in accordance with the results of an earlier study which dealt with determining the effects of unilateral, bilateral, and combined unilateral and bilateral plyometric training on the performance of sprinting 15 and 30 m in young soccer players (Ramirez-Campillo et al., 2014). Identical to the results presented here, all experimental groups showed a significant increase in the sprint variables. The authors state that a possible reason for the improvement in sprinting at the specified distances in both groups is the use of horizontal jumps (Ramirez-Campillo et al., 2014). Regarding agility performance, our findings are also in accordance with some previous studies. Namely, in the research on young soccer players, participants were divided into three groups - control, and two experimental groups with different types of plyometric training) (Ramirez-Campillo et al., 2015). The results demonstrate that all plyometric groups achieve a significant increase in agility performance, with small to moderate effect

sizes. Similar findings were obtained in the study where the effects of horizontal and vertical plyometric modalities were analyzed (Manouras, Papanikolaou, Karatrantou, Kouvarakis, & Gerodimos, 2016). In particular, results showed similar improvements in speed and agility performance in both groups (Manouras et al., 2016).

Conclusion

The results of this study showed a positive effect of plyometric training on speed, acceleration, and agility performance among soccer players. However, more interestingly, no differences in treatment effect were found between the groups that performed unilateral and bilateral jumps. In general, it seems that systematic plyometric training, independent of specific training modalities, can improve explosive capacities in youth athletes. These findings provide valuable information for sports practitioners involved in the development of young athletes, showing that even fundamental types of jumps can gain advancement in players of this age. Therefore, it is necessary that in the process of implementing plyometric training with young athletes, coaches respect the methodical principles of progressiveness and gradualness.

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Conflicts of interest
The authors declare that there are no conflict of interest.

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