

The effect of plyometric training program on agility, jumping, and speed performance in young soccer players

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Abstract

Background and Study Aim The aim of this study was to examine the effect of a 6-week plyometric training program on agility, vertical jump, squat jump, and speed performance in soccer players.

Material and Methods A total of 26 male soccer players actively playing for Ankara Batıkent Kartal Sports Club participated in the study as volunteers. The players had an average age of 15.04 ± 0.16 years, an average height of 172.48 ± 5.14 cm, and an average body weight of 62.65 ± 0.38 kg. Data on the players' gender, age, body weight (kg), height (cm), body mass index (BMI), agility, vertical jump (cm), squat jump, and 30 m speed were obtained. Statistical analysis was performed using SPSS 25 software. The normality of the data was examined using the Shapiro-Wilk test. Paired samples t-test was used to determine within-group differences, and independent samples t-test was used to determine differences between groups. A statistical significance level of $p < 0.05$ was considered for all evaluations.

Results The plyometric training program was effective in improving agility, vertical jump, squat jump, and speed performance in the experimental group. There was a significant difference in agility and 30 m speed values in the pre-test and post-test evaluations of the Control group, but no difference was observed in vertical jump and squat jump values. Additionally, in the pre-test and post-test comparison between the experimental and control groups, a significant difference was observed in agility, vertical jump, and squat jump values. However, no significant difference was found in 30 m speed values.

Conclusions That plyometric training program is effective in improving agility, vertical jump, squat jump, and 30 m speed values.

Keywords: plyometric training, exercise, strength, performance, soccer

Introduction

Soccer is a highly complex sport discipline involving intermittent and intense loading periods. In contemporary soccer, physiological assessments are increasingly important not only for adults but also for young athletes to achieve optimal performance. Successful performance in soccer relies heavily on fundamental motor skills such as repeated explosive capacity, strength, speed, ball striking ability, as well as additional skills like jumping, turning ability, sprinting, and direction change. All these attributes significantly contribute to enhancing players' performance [1].

Considering the intensive nature of soccer, delivering high-level performance throughout a ninety-minute match can only be achieved through a well-prepared training program that addresses the athlete's physical and physiological needs [2].

Within the scope of soccer, there continues to be debate regarding the extent to which physical components such as speed, agility, and strength – essential attributes of soccer players – can be developed through soccer-specific training.

However, researchers emphasize that plyometric training is one of the training methods that can enhance competition performance along with increasing strength and power components [3].

Plyometrics, a widely used training method among athletes in various sports disciplines, focuses on developing strength and explosiveness [4]. This technique involves the rapid stretching (eccentric movement) of muscles followed immediately by their shortening (concentric movement) [5]. Plyometrics enable athletes to produce more force than would be possible with only concentric movements by utilizing the elastic energy stored in the muscles [6, 7].

The advantages of incorporating plyometric exercises into a periodic strength training program have been repeatedly demonstrated by numerous studies. These benefits include improved proprioception, acceleration, leg strength, muscle power, and jumping performance [8, 9, 10]. These findings highlight the beneficial effects of plyometric exercises when paired with a structured strength training program.

Plyometric exercises typically involve explosive movements that require sudden stops, starts, and changes in direction. These dynamic movements

play a crucial role in developing agility [11, 12, 13]. Agility refers to the ability to rapidly change direction while effectively controlling body position through a series of movements [14]. Agility training aims to strengthen neuromuscular conditioning, adapt muscle spindles, Golgi tendon organs, and joint proprioceptors, enhancing neuromuscular programming [15, 16]. Agility training has the potential to improve overall agility by increasing balance and control of body positions during movement.

This study aims to examine the effects of a 6-week plyometric training program on agility, jumping, and speed parameters – essential elements of the soccer discipline – in young soccer players.

Methods And Materials

Participants

A total of 26 male soccer players actively playing for Ankara Batikent Kartal Sports Club volunteered to participate in the study. The players had an average age of 15.04 ± 0.16 years, an average height of 1.72 ± 0.00 cm, and an average body weight of 62.65 ± 0.38 kg. The athletes were informed about the purpose of the study, and signed informed consents were obtained, in accordance with the requirements of the Declaration of Helsinki for Human Research.

Research Design

The heights of the research group were measured using a stadiometer (Holtain brand), and their body weights were measured using a digital scale (Tanita BC 480). Body Mass Index (BMI) was calculated using the formula:

$$\text{BMI} = \text{body weight (kg)} / \text{height (m)}^2$$

Additionally, participants' speed performances were assessed using the 30-meter sprint test, agility was assessed using the T-test, and vertical jump and squat jump heights were evaluated using the Microgate optojump® system (Microgate, Bolzano, Italy).

Height Measurement. The height of the participating soccer players was measured using a stadiometer (Holtain brand) with a precision of 0.1 cm. To determine height, the stadiometer was positioned at the top of the head after the individual took a deep breath with their head upright and eyes looking straight ahead [17].

Body Weight. The body weights and body fat percentages of the soccer players were measured using a Tanita BC 480 scale while wearing shorts and no shoes.

Body Mass Index (BMI) Calculation. The BMI of the players was calculated using the formula: $\text{body weight (kg)} / \text{height (m)}^2$.

Vertical Jump. The vertical jump test was conducted using two OptoJump devices (Microgate, Italy) placed facing each other. When ready, the

athlete performed a short downward movement followed by jumping upwards with hands on hips and feet fixed on the ground. Any errors such as releasing hands, opening or closing knees or feet during the jump were considered invalid, and the measurement was discarded. The test was repeated twice at 30-second intervals, and the highest jump height was recorded.

Squat Jum. Squat jump tests were conducted using the OptoJump device, which has been validated and found reliable for squat jump tests [18]. Participants were instructed to squat to a 90° angle, pause for 1-2 seconds, and then jump vertically without leaning forward with hands on hips. Bending knees at 90°, separating hands from hips during the jump, or bending knees during flight phase were considered incorrect movements [19].

Sprint Measurement. The 30-meter sprint times of the athletes were measured on the soccer field using photoelectric cells. Each participant performed two rapid sprint tests with a 3-minute rest interval between tests. The best performance between the repeated sprint tests was recorded.

Agility T-Test. The T-Test was conducted on a designated area measuring 10 meters in length and width, forming a T-shape with four contact points. The aim was for the participant to complete a series of movements between these contact points in the shortest time possible. Unlike other agility tests, the participant always faced the same direction and changed direction by shuffling to the right or left or by running backwards. The test required completing two 90° and 180° turns, as well as running forward, right, left, and backward for a total distance of 40 meters.

Training Program. Participants were randomly divided into two groups: experimental (n=13) and control (n=13). The training intervention lasted for 6 weeks, with two sessions per week for the soccer team. While the experimental group followed a plyometric training program, the control group continued with their regular training routine. Pre- and post-training tests were conducted before and after the implementation of the training program. Prior to the test protocols, participants underwent a familiarization session to ensure no issues during the testing. All tests were conducted on a grass field under suitable conditions, at least 48 hours after previous training sessions or matches. Participants were instructed to wear the same athletic gear during testing sessions. Measurements were taken at the same time of day during two testing sessions to minimize the effects of daily fluctuations on selected parameters. Participants were also provided with information regarding nutrition and rest during the training and testing processes to mitigate any factors that could affect the study results. The applied training program is detailed in Table 1.

Statistical Analysis

The SPSS 25 software was utilized for statistical analysis of the collected data. Descriptive statistics, including arithmetic mean and standard deviation, were used to present the data. The Shapiro-Wilk test was employed to assess whether anthropometric and performance parameters followed a normal distribution. It was observed that the data exhibited a normal distribution. Therefore, paired samples t-test was used for data showing normal distribution, while independent samples t-test was used to determine differences between groups. A significance level of $p < 0.05$ was considered for all evaluations.

Upon examination of the table, it can be observed that the experimental and control groups have similar descriptive statistics (tbl. 2).

Results

This section presents the statistical analysis and interpretations of the data obtained from the research group.

Upon examination of Table 3, statistically significant differences are observed in the pre-test and post-test values of agility, 30m sprint, vertical jump, and squat jump for the Experimental group ($p < 0.05$). Based on these findings, it can be concluded that the applied plyometric training is effective in improving agility, 30m sprint, vertical jump, and squat jump.

Upon examination of Table 4, statistically significant differences are observed in the pre-test and post-test values of agility and 30m sprint for the Control group ($p < 0.05$). However, no significant differences are observed in the values of vertical

Table 1. Plyometric Training Program

Week	Training Days	Plyometric Training	Sets	Reps	Rest	Training Duration
1. ve 2. week	96	-Side to Side Hops	2	8	3 min.	35-40 min.
		-Box Jump (15 cm)				
		-Drop Jump				
		-Hurdle Jump (15 cm)				
		-Squat Jump				
3. ve 4. week	144	-Side to Side Hops	2	12	3 min.	35-40 min.
		-Box Jump (20 cm)				
		-Drop Jump				
		-Hurdle Jump (20 cm)				
		-Squat Jump				
5. ve 6. week	180	-Side to Side Hops	3	10	3 min.	35-40 min.
		-Box Jump (30 cm)				
		-Drop Jump				
		-Hurdle Jump (30 cm)				
		-Squat Jump				

Table 2. Descriptive Statistics for the Research Group (n=13)

Group	Variables	Mean	Standard deviation
Experiment	Age (Year)	15.00	0.22
	Body Weight (kg)	62.92	6.51
	Height (cm)	173.23	6.45
	Body Mass Index (BMI)	20.90	0.20
Control	Age (Year)	15.08	0.23
	Body Weight (kg)	62.38	4.59
	Height (cm)	172.54	5.21
	Body Mass Index (BMI)	22.93	0.22

Table 3. Dependent Samples t-Test Results for Pre-test and Post-test Evaluations of the Experimental Group

Variables	Tests	Mean	Sd	t	p-value
Agility (s)	Pre-test	12.28	0.56	3.17	.000*
	Post-test	12.11	0.52		
30m Sprint (s)	Pre-test	5.19	0.05	18.50	.000*
	Post-test	5.16	0.05		
Vertical Jump (cm)	Pre-test	32.61	2.95	-32.18	.000*
	Post-test	35.70	2.73		
Squat Jump (cm)	Pre-test	24.79	1.29	-19.54	.000*
	Post-test	27.24	1.51		

P<0.05*; Sd: Standard deviation

Table 4. Dependent Samples t-Test Results for Pre-test and Post-test Evaluations of the Control Group

Variables	Tests	Mean	Sd	t	p-value
Agility (s)	Pre-test	12.92	1.30	4.60	.043*
	Post-test	12.81	1.23		
30m Sprint (s)	Pre-test	5.20	0.06	2.92	.013*
	Post-test	5.19	0.07		
Vertical Jump (cm)	Pre-test	35.70	2.79	3.68	.159
	Post-test	33.29	2.71		
Squat Jump (cm)	Pre-test	25.77	1.62	-1.62	.131
	Post-test	25.92	1.54		

P<0.05*; Sd: Standard deviation

Table 5. Independent Samples t-Test Results for Pre-test and Post-test Comparisons between the Experimental and Control Groups

Variables	Tests	Experiment		Control		P-value
		Mean	Sd	Mean	Sd	
Agility (s)	Pre-test	12.28	0.56	12.92	1.30	.123
	Post-test	12.92	0.52	12.81	1.23	.047*
30m Sprint (s)	Pre-test	5.19	0.05	5.20	0.06	.568
	Post-test	5.16	0.05	5.19	0.07	.276
Vertical Jump (cm)	Pre-test	31.61	2.95	35.70	2.79	.122
	Post-test	35.70	2.73	33.29	2.71	.034*
Squat Jump (cm)	Pre-test	24.79	1.29	25.77	1.62	.101
	Post-test	27.24	1.51	25.92	1.54	.038*

P<0.05*; Sd: Standard deviation

jump and squat jump ($p>0.05$).

In Table 5, the pre-test and post-test means of agility, 30m sprint, vertical jump, and squat jump for the Experimental and Control groups were compared. Statistical analysis revealed a significant difference in the mean values of agility, vertical jump, and squat jump ($p<0.05$). However, no significant difference was found in the mean values of the 30m sprint test between the Experimental and Control groups ($p>0.05$).

Discussion

The aim of this study was to investigate the effects of a 6-week plyometric training program on agility, vertical jump, squat jump, and speed performance in soccer players. The results indicate that the 6-week plyometric training led to improvements in jumping, speed, and agility performance. This suggests that plyometric training can enhance jumping performance and explosive power.

Vertical jump, a physical attribute crucial for high-level performance, varies in importance

depending on the position in football. Explosive strength, associated with high-level performance, is crucial in sports like football [20]. Researchers have pointed out that these attributes can be improved with plyometric training [21, 22].

Previous studies consistently report significant improvements in vertical jump performance among male and female athletes after plyometric training [23, 24]. The findings of this study support these results, as the plyometric training program resulted in a significant difference in jumping ability between the experimental and control groups.

Plyometric exercises can be performed with or without external loads, and both modalities have been shown to increase strength, jump height, and sprint performance [25, 26].

Many studies in the literature support our findings [27, 28]. The results of this study suggest that plyometric training methods enhance jumping performance more than traditional football training.

Additionally, plyometric exercise has been described as biphasic [29] in the countermovement jump (CMJ) or monophasic in the squat jump (SJ). The plyometric protocol used in this study not only allows for greater power production and neuromuscular adaptation through the stretch-shortening cycle (SSC) but also improves the activation of synergistic muscles and concentric contraction due to the variation and combination of different exercises [30].

Jumping performance assessed through SJ and CMJ tests is improved by the reactive ability of muscles trained in both plyometric and specific training [31].

Plyometric training, which plays an important role in strength and jumping efficiency in football training, positively affects athletes' jumping and explosive power, improving their performance [32].

When examining the physical properties affecting high performance in sports, speed, mobility (flexibility), and coordination can be considered determinants [33]. In this context, when the pre-test and post-test measurement values of the experimental group are examined, statistically significant differences in speed values are observed. It is seen that the post-test measurement values are better when the mean values are compared.

In previous studies, Markovic et al. [34] conducted a study with 93 male students, divided into sprint, plyometric, and control groups. The study found statistically significant increases in values in the sprint and plyometric groups. Similarly, Arslan [35] indicates that combined plyometric applications with other training programs improve sprinting ability. In another study, Agilonu and Kiratlı [36] found a statistically significant difference in the 30m speed values of the experimental group. In a study by Villarreal et al., [37] it was found that plyometric training combined with maximal strength and

heavy resistance training significantly improved sprint and endurance performance. In a study with a sample of basketball players, Bavlı [38] concluded that 6 weeks of plyometric exercises improved vertical jump and 30m speed performance. It can be said that the development in the experimental and control groups, in line with the results obtained, affects the speed property together with plyometric training and football training.

In sports where instant change of direction is necessary, quick force and elastic force performance are determinant characteristics. Athletes require a lot of elastic force when they need to change direction instantly. Plyometric exercises are of great importance in sports to develop the ability to instantly change direction and maintain balance in the game. In this context, when the pre-test and post-test measurement values of the experimental group are examined, statistically significant differences in agility values are observed. It is seen that the post-test measurement values are better when the mean values are compared [39].

In a study investigating the effect of 6 weeks of plyometric training on agility, the t-test found statistically significant differences in agility values between the pre-test and post-test of the experimental group athletes. The control group was not found to be statistically significant [40]. In another study examining the effect of plyometric training on athletes' agility performance, improvement in agility values was observed after 8 weeks of training [41].

Upon reviewing the findings in the discussion section, jumping and speed ability are directly related to leg and hip strength. Various methods have been developed, especially to improve leg strength. Plyometric training is the most commonly used method [42]. When plyometric exercises are performed regularly and correctly, they contribute to performance improvement in sports (e.g. , football, handball, volleyball), where jumping and speed parameters are crucial [43, 44].

Conclusions

The results of this study clearly demonstrate the efficacy of a 6-week plyometric training program in enhancing key athletic performance indicators among young male soccer players. These enhancements are particularly relevant for soccer players, as agility and jumping capabilities are critical for competitive performance, affecting everything from evading opponents to aerial duels. This study affirms the value of incorporating plyometric exercises into the training regimens of young soccer players to enhance their physical capabilities, thereby potentially improving their on-field performance. Coaches and trainers should consider integrating plyometric training into their athletic development programs to exploit its benefits fully.

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Conflict of interest

The authors declare no conflict of interest.

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