Effect of plyometric training on athletic performance in preadolescent soccer players

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ABSTRACT

Michailidis, Y. (2015). Effect of plyometric training on athletic performance in preadolescent soccer players. *J. Hum. Sport Exerc., 10*(1), pp.15-23. The aim of this study was to investigate the effectiveness of plyometric training on performance of preadolescent soccer players. 21 players assigned to two groups: jumping-group (JG, n = 11) and control-group (CG, n = 10). Training program was performed for 10 weeks. Anaerobic power performances were assessed by using standing long jump (SLJ), 10 m and 30 m sprint. In the JG the performance at the long jump was increased significantly (P = 0.031). Also the performance of JG increased at 30m sprint running by 7.2 % (P < 0.001). None of the variables tested in the CG demonstrated difference between the pre-test and the post-test. Our results indicate that plyometric training can improve running performance at 30 m sprint and the performance at standing long jump in preadolescent soccer players. **Key words**: PLYOMETRIC, JUMP, SPRINT, PERFORMANCE, PREADOLESCENT.

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INTRODUCTION

Today the soccer is becoming more dynamic and the power has become an important aspect of condition for soccer players of all ages. If we take a look at typical movement sequences in soccer (abrupt stops and changes of direction, quick sprints, ball kicking and explosive shots) makes it clear that depend on the stretch-shortening cycle (SSC) characteristics of the involved muscles (Manolopoulos et al., 2004). Such actions generate explosive release and impact in a repetitive manner use the SSC and require rapid force production and high power output.

Plyometrics exercises are suitable for improving various measures and components of muscle power such as vertical jumping ability, speed and acceleration (Fatouros et al., 2000; Gheri et al., 1998). Despite the hundreds of human studies that investigated the effects of this kind of exercises on vertical jumping performance and running velocity, the vast majority of them have performed to adults (Fatouros et al., 2012; Ford et al., 1983). Few studies have accomplished to prepubertal boys (Kotzamanidis, 2006; Lehance et al., 2006). The relevant studies have reported that plyometric exercises improve jumping power and running velocities (Fatouros et al., 2012; Young et al., 1999).

The aim of the present study was to investigate the influence of short-term plyometric training on running velocity and horizontal jumping ability in a small sample of preadolescent boys.

MATERIAL AND METHODS

Participants

Thirty two healthy preadolescent male soccer players volunteered to participate in this study. From those eleven boys were excluded because they exceeded the stages of puberty development according to Tanner scale (first stage). Twenty one soccer players participated. All the subjects were members to the same team, participating in no more than 4 times per week in soccer training (3 trainings and 1 game). The subjects were randomly assigned to a training group (jump group, JG n = 11) or a control group (CG, n = 10). All the subjects were of prepubertal status according to Tanner's (1962) criteria. A written informed consent to participate in the study was provided by all participants and their parents after they were informed of all risks, discomforts and benefits involved in the study. Also the study complies with the ethical recommendations of the declaration of Helsinki.

Procedure

For three weeks before the tests, the team performed a program to protect players from injuries (Faigenbaum et al., 2009; Fry et al., 1991). The program included strength, flexibility and endurance exercises. Also in this period the players familiarized with the tests which accomplished in an indoor sport hall.

Sprint testing

Running performance evaluated with a 30m sprint running. Subjects performed 2 maximal efforts with a 3 minutes interval between trials. For analyses we use the best try. We use 3 pairs of opto-reflective switches (Tag Heuer) that were located at the start and at the end of 30m sprint and also at 10m after the beginning. This system was connected with an electronic chronometer (Omega System) to record the time.

Jump test

The participants performed a standing long jump. They stand behind a line marked on the ground with feet slightly apart. A two foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. The subjects attempt to jump as far as possible, landing on both feet without falling backwards. The measurement used was the longest of three tries.

Training Program

The duration of the program was 10 weeks and included jumping and running exercises. More specific the subjects performed jumps with two legs and one leg and skipping exercises. Regular soccer practice was performed 3 times per week and induced execution of soccer technical skills, tactics, speed work, and pick-up games. Plyometric training was performed twice a week during the first and third soccer practice each week. The initial number of jumps per session was 60 (without skipping exercises) and gradually increased to 120 jumps at the end of the training period (Table 1).

Table 1. Total sum of jumps and meters of skipping exercises per training session

Week	Exercise	Direction	Sets	Repetitions/meters
1st	jumps between lines with 2 legs	Forward	5	10
	20 cm hurdle hops	Forward	2	5
	skipping	Forward	3	10 m
2nd	jumps between lines with 2 legs	Forward	6	10
	20 cm hurdle hops	Diagonal	2	5
	skipping	Forward	3	10 m
3rd	jumps between lines with 2 legs	Forward	7	5
	skipping	Forward	3	10 m
4th	jumps between lines with 1 leg	Forward	6	10
	20 cm hurdle hops	Lateral	3	5
	skipping	Forward	5	10 m
5th	jumps between lines with 2 legs	Forward	8	10
	skipping	Forward	2	10 m
6th	jumps between lines with 1 leg	Forward	7	10
	30 cm hurdle hops	Diagonal	3	5
	skipping	Forward	3	10 m
7th	jumps between lines with 2 legs	Forward	8	10
	40 cm hurdle hops	Forward	2	5
	skipping	Forward	3	10 m
8th	jumps between lines with 1 leg	Forward	9	10
	skipping	Forward	3	10 m
9th	jumps between lines with 2 legs	Forward	11	10
	40 cm hurdle hops	Forward	2	5
	skipping	Forward	2	10 m
10th	jumps between lines with 2 legs	Forward	11	10
	20 cm hurdle hops	Lateral	3	5
	skipping	Forward	2	10 m

Statistical Analyses

Data analysed by a two-way repeated measures (trial × time) ANOVA. If a significant interaction was obtained, pair wise comparisons were performed through simple contrasts and simple main effects analysis. The level of significance was set at $\alpha = 0.05$. The SPSS version 13.0 was used for all analyses (SPSS Inc., Chicago, IL). Data are presented as mean ± SD.

RESULTS

Before training all baseline anthropometric characteristics were similar between JG and CG (Table 2). Training did not affect the participants' anthropometric profile (P = 0.08). In the JG the performance at the long jump was increased by 5.63% (P = 0.031) whereas for CG no significant changes were observed (P = 0.076) (Figure 1). At posttraining sprint time demonstrated a decline in JG only but was not significant (P = 0.063) (Figure 2). In the JG the performance at 30 m was increased by 7.2% (P < 0.001). In contrast the performance of the CG no changed (P = 0.061) (Figure 3). Significant differences observed between the two groups (JG and CG) in long jump (P = 0.026) and at 30m sprint (P = 0.034) (Figures 1 and 3). In the JG the changes in long jump correlated significant with the changes in the 10 and 30m sprints (P = 0.003, r = 0.615, P = 0.016, r = 0.517 respectively).

Table 2. Participants' physical characteristics and training age

	CG (n = 10)		JG (n = 11)	
	Pretraining	Posttraining	Pretraining	Posttraining
Age (y)	11.3 ± 0.6	11.5 ± 0.6	11.4 ± 0.6	11.6 ± 0.6
Height (cm)	147 ± 6	148 ±7	146 ± 7	148 ± 7
Weight (kg)	42.3 ± 7.1	43.5 ± 6.6	43.2 ± 5.2	43.8 ± 5.5
Training age (y)	3.8 ± 0.5		3.7 ± 0.8	

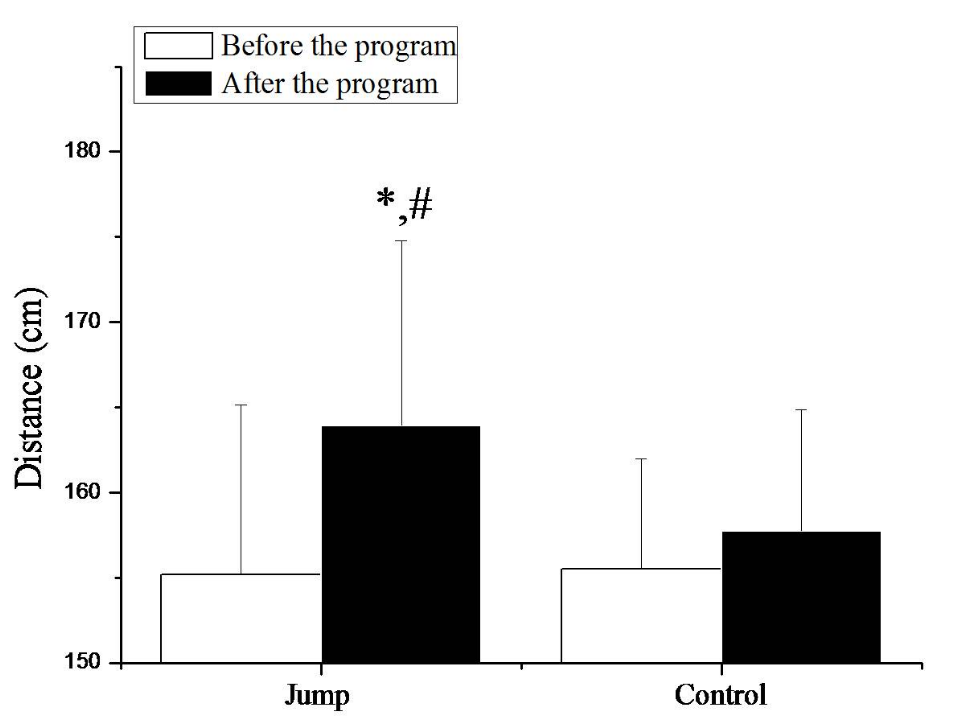

Figure 1. Changes in jump performance. * Denotes significant (P < 0.05) difference with baseline values; # denotes significant (P < 0.05) differences between groups

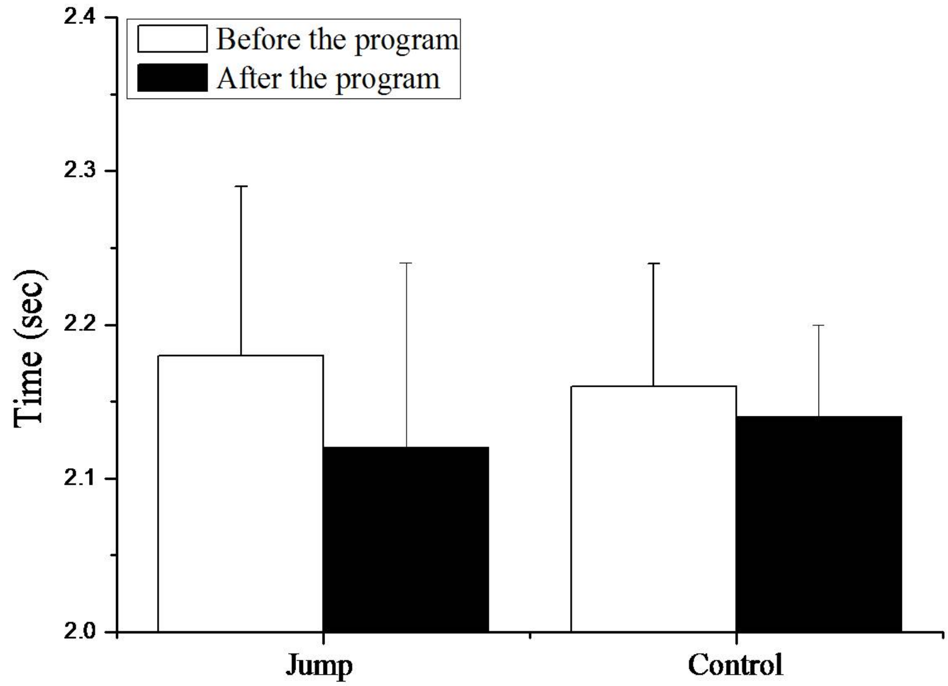

Figure 2. Changes in sprint times across time (10 m)

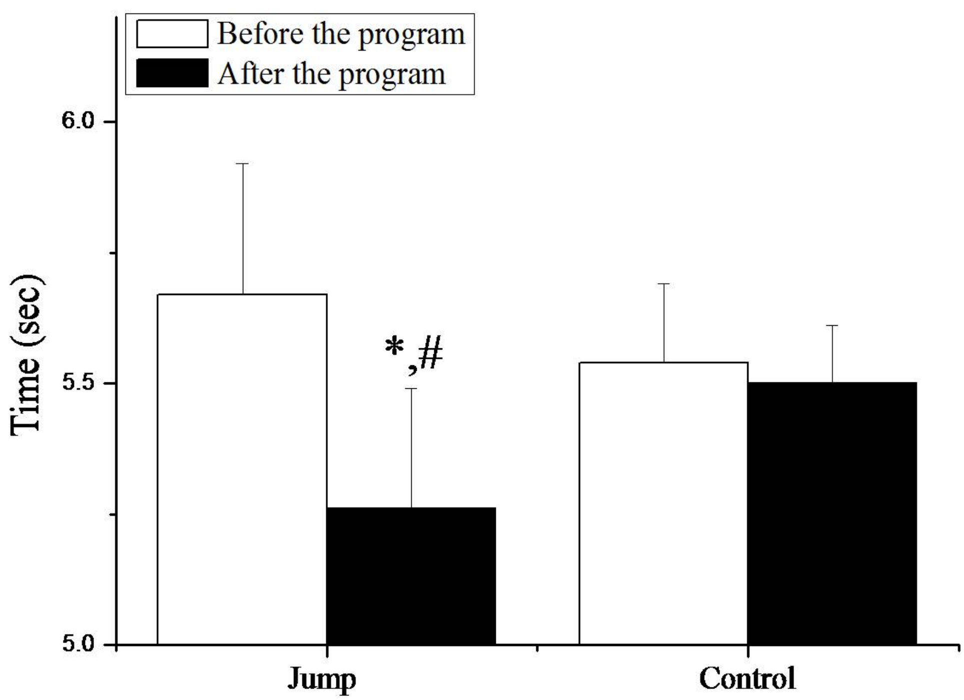

Figure 3. Changes in sprint times across time (30 m). * Denotes significant (P < 0.05) difference with baseline values; # denotes significant (P < 0.05) differences between groups

DISCUSSION

Training with plyometrics has been extensively used for augmenting jumping performance in healthy individuals. This kind of exercise improves different type of jumps like squat jump (SJ), counter movement jump (CMJ), depth jump (DJ), long jump (LJ) (Kubo et al., 2007; Saunders et al., 2006). In some cases observed lack of adaptations that may be related to the nature of the selected exercises for plyometric training (Sale, 1992).

In our study we measure standing long jump. From the literature for horizontal jumping performance it's observable that plyometrics increase performance in both athletes (Paavolainen et al., 1999; Spurrs et al., 2003) and non-athletes (Markovic et al., 2007). Few studies examined this issue to children and the most of them found enhancement of jumping ability (Diallo et al., 2001; Lehance et al., 2006; Michailidis et al., 2013). Our findings are to accordance with those of Diallo et al. (2001), Kotzamanidis (2006) and Lehance et al. (2006). They found that the performance at some kinds of jump (squat jump, standing long jump and at counter movement jump) improved significantly.

A lot of movements in soccer include jumping, hopping and bounding that characterized by the use of the stretch-shortening cycle (SSC) that develops during the transition from a rapid eccentric muscle contraction to a rapid concentric muscle contraction (Markovic et al., 2007; Markovic & Mikulic, 2010). The improvement in speed performance after plyometric training has been attributed to an improvement in ground contact time and muscle tendon stiffness (Mero et al., 1991; Meylan & Malatesta, 2009; Rimmer & Sleivert, 2000). Improvements in sprint performance mentioned in literature (Dodd & Alvar, 2007; Lehance et al., 2005; Markovic et al., 2007; Michailidis et al., 2013; Paavolainen et al., 1999; Rimmer & Sleivert, 2000; Robinson et al., 2004; Tricoli et al., 2005; Wagner & Kocak, 1997; Wilson et al., 1996). On the other hand we have to mention that slight decreases in sprint performance following plyometrics have also been observed (Chimera et al., 2004; Dodd & Alvar, 2007; Herrero et al., 2006; Hortobagyi et al., 1991).

In our study we found that the program improves the running velocity (0-30m) in preadolescents. However Meylan and Malatesta, and Ingle et al. reported a marked reduction of the initial acceleration time and maximal velocity phase of soccer players during early puberty. Kotzamanidis after a training program with plyometrics (10 weeks duration) found that in JG the velocity for the running distances 0-30, 10-20 and 20-30 m increased but not for the distance 0-10 m. In another study, Diallo et al., (2001) investigate the effectiveness of plyometric training on physical performances in prepubescent soccer players. Some of the findings showed that the performances at 20 m running velocity increased at JG. Also our results were in line with the findings of Lehance et al. (2006) and Michailidis et al. (2013). These researchers found that strength and plyometric exercises can improve the ability of sprint in preadolescent soccer players.

A possible explanation for running velocity enhancement at 0-30m and for jumping ability improvement is the increase of force and power of the athletes. Also strength development is associated with a variety of neuromuscular factors (Markovic & Mikulic, 2010) and does not solely depend on muscular mass. At stretch-shortening cycle muscle function, a pre-stretch enhances the maximum force and work output that muscles can produce during the concentric phase. This is the ability that plyometric exercises can improve.

In the present study we observed that a correlation between the performance at long jump and sprint running to preadolescent boys.

This study has some limitations. We use only Tanner scale to estimate the stage of puberty. It is more accurate if you can use extra the bone age and testosterone values. Also for jumping ability we use only the studying long jump test and we did not execute any test for vertical jumping ability.

CONCLUSIONS

In the literature we present studies that examined the influence of training methods (like strength and endurance) to physical performance in young soccer players (Christou et al., 2006). However the plyometric exercises believed that were dangerous and may cause injuries to bones' growth plates that may result in leg-length discrepancy (Faigenbaum & Yap, 2000; Witzke & Snow, 2000) and its association with muscle and tendon damage (Jamurtas et al., 2000; Tofas et al., 2008) which is accompanied by a marked inflammatory response (Chatzinikolaou et al., 2010). So the coaches avoided to perform this kind of exercises. Recent studies prove that if we choose the right exercises we can improve the performance (running velocity and standing long jump) of young soccer players without health risks.

However we have to investigate the influence of different training methods to physical performance of children.

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