

Effects of plyometric versus resistance training on sprint and skill performance in young soccer players

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ABSTRACT

The aim of this study was to investigate the effect of plyometric versus resistance training (PT vs. RT) on sprint and skill performance in young soccer players. Thirty elite soccer players participated in this study as the subject. The subjects were randomly assigned to PT group (n=10, age: 19.1 ± 1.7 years), RT group (n=10, age: 18.0 ± 0.81) or control group (n=10, age: 18.8 ± 1.5 years). The PT group performed 8 weeks lower extremities PT besides the soccer team training. The RT consisted of 2-4 sets of weight training for 4 stations and at an intensity corresponding to 60-90% of 1-RM in each station by 6-12 repetitions besides the soccer team training. The control group performed only the soccer team training during the study. The results showed that the time of sprint running test and dribbling improve after PT and RT (P<0.05). For accuracy of shooting no significant change was observed after 8 weeks PT and RT. In conclusion, although the time of sprint running test and dribbling improve after PT and RT, these training have not effective to improve accuracy of shooting in young soccer players.

Key words: Plyometric training, Young soccer players, Shooting, Dribbling, Sprint

INTRODUCTION

During a 90-minute soccer match, professional soccer player makes numerous explosive bursts, like kicking, tackling, jumping, turning, sprinting, and changing pace [4]. Speed strength, also known as power, is crucial for the performance in sports where changes of direction, accelerations, and jumps are importance [13]. Hence, strength and power in leg muscles are important for professional soccer players. Maximal strength is an important quality for power performance, because power is the product of force (strength) and velocity (speed). Thus, an increase in 1RM is usually related to improved power abilities [19]. Research results showed that heavy strength training on leg extensor muscles improved power, jumping height and sprint performance in professional soccer players [11, 19]. Plyometric training (PT) is a widely used method to improve muscles' ability to generate explosive power. Plyometric is a type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of improving performance in a specific sport. PT, in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervations of muscle and surrounding tissues to jump higher, run faster, throw farther, or hit harder, depending on the desired training goal [2]. PT has been shown to increase power, jumping height and sprint performance [9, 20]. However, contradictory results exist regarding the effects of PT on speed-power measurements [10, 20], as well as for the effect of heavy resistance training (RT) [9, 20]. RT and PT may affect different aspects of speed and power related skills, thus we examined the effect of PT versus RT on sprint and skill performance in young soccer players.

MATERIALS AND METHODS

Participants

Thirty elite young soccer players (age, 16-21 years) participated in this study as the subject. The subjects were randomly assigned to PT group (n=10), RT group (n=10) or control group (n=10).

All subjects were nonsmokers and none used ergogenic aid or were users of medications known to affect cardio respiratory function during the study. The protocol of this study was in accordance with the guidelines of the Islamic Azad University, Jahrom branch Ethics Committee and all participants gave their written consent.

Training protocols

The training protocols included only leg exercises. None of the subjects had used PT or RT before. General and specific warm-up was performed prior to each training session. All subjects a standardized warm-up prior to the exercise training. Subjects jogged for an 8-minute period at a moderate pace and then performed 7 minute stretching movements. PT group performed 8 weeks lower extremities PT besides the soccer team training. PT programs were designed to overload the leg muscles involved in the vertical jumping motion and explosive performance. The subjects in the PT group performed four plyometric drills – the Depth jump, the Split squat jump, the Rim jump, the Box to box depth jump. The depth jump height started at 22 centimeters on the first week and progressed to 50 centimeters in the last week. The distance between boxes started at 1 meter on the first week and progressed to 2 meter in the last week. Two familiarization sessions were designed to habituate subjects in the RT group with the testing procedures and laboratory environment. The main aim of these sessions was to familiarize subjects with different resistance exercises using weight-training machines and also to familiarize them with performing the 1-RM test. During the familiarization sessions, it was ensured that all the subjects used the correct techniques for all exercises prior to taking part in the main test sessions. Subjects executed four resistance exercises selected to stress the major muscle groups in the following order: leg extension, leg curls, leg press, and seated calf raise. RT consisted of 2-4 sets of weight training for 4 stations and at an intensity corresponding to 60-90% of 1-RM in each station by 6-12 repetitions besides the soccer team training. Each training session was followed by 10 minute cool-down. The control group performed only the soccer team training during the study.

Measurements

Anthropometric and body composition measurements

Height and weight were measured, and body mass index (BMI) was calculated by dividing weight (kg) by height (m^2). Waist circumference was determined by obtaining the minimum circumference (narrowest part of the torso, above the umbilicus) and the maximum hip circumference while standing with their heels together. The waist to hip ratio (WHR) was calculated by dividing waist by hip circumference (cm) [1]. Body fat percentage was assessed by skinfold thickness protocol. Skinfold thickness was measured sequentially, in triceps, subscapular, and chest by the same investigator using a skinfold caliper (Harpenden, HSK-BI, British Indicators, West Sussex, UK) and a standard technique [1].

Speed measurement

To measure the speed repetitive sprinting test was used. Thus subjects performed six distances of 15 meters sprint that were interspersed by 30 seconds of recovery. The recovery was active rest (walking slowly) [14].

Accuracy of shooting measurement

Accuracy of shooting was measured, by kick a role ball into a 0.8×2.3 meters target constructed in the center of goal. Strike zone was constructed with dimensions of 1×1 meter then this zone 7 meters away from the target. Subjects with 5.5 meters away from this area were located. Four balls were rolled from the player right-hand side and followed by four balls from the players' left-hands side. Balls were rolled at 6 seconds intervals. Players were instructed to kick the ball with their dominant kicking foot when it reached to strike zone. Between each ball strike, player returned to a baseline position 5.5 meters behind the strike zone before approaching the next ball. Subject repeated this procedure until striking the ball eight. For every ball into the target, one score for subjects was recorded [14].

Dribbling test

In the dribble test five cones on a line with a distance 1 m between them were used. Starting point was a 1 meter distance from the first cone. Each subject was standing at the start point while holding the ball under his dominant foot, by hearing the whistle he began the dribble test with maximum speed and in the moment of passing the last cone, he return to the starting point with his maximum speed. Time of performance was recorded by the timer [14].

Statistical analysis

Results were expressed as the mean \pm SD and distributions of all variables were assessed for normality. Statistical significance was determined by analysis of variance (ANOVA). Bonferroni post hoc comparisons were used to determine the source of significant differences where appropriated. The level of significance in all statistical analyses was set at $P \leq 0.05$. Data analyses were performed using SPSS software for windows (version 13, SPSS, Inc., Chicago, IL).

RESULTS*Changes in anthropometric variables*

Anthropometric and body composition characteristics of the subjects at baseline and after training are presented in Table 1. Before the intervention, there were no significant differences in any of variables among the three groups. Body weight, BMI and body fat percentage decreased after PT compare to the RT and control groups ($P < 0.05$). For WHR no significant changes were observed after the PT or RT.

Table 1. Anthropometric and body composition characteristics (mean \pm S.D.) of the subjects before and after 8 weeks of PT, RT and control condition.

	Plyometric training		Resistance training		Control	
Body weight (Kg)	71.9 \pm 8.9	70.4 \pm 8.5* [†]	64.8 \pm 11.8	66 \pm 13.7	62.4 \pm 6.8	62.9 \pm 6.8
BMI (Kg/m ²)	23.5 \pm 2.4	23 \pm 2.3* [†]	20.8 \pm 3.4	21.2 \pm 3.8	20.2 \pm 2.7	20.4 \pm 2.7
Body fat (%)	8.1 \pm 1.9	7.2 \pm 1.8* [†]	6.2 \pm 2.2	6.5 \pm 2.2	5.8 \pm 1.7	6 \pm 1.6
WHR	0.84 \pm 0.03	0.83 \pm 0.05	0.85 \pm 0.03	0.85 \pm 0.04	0.84 \pm 0.07	0.83 \pm 0.05

* Significant difference ($P < 0.05$) between PT and control trials

† Significant difference ($P < 0.05$) between PT and RT

Changes in the sprint and skill performance

The results showed that the time of sprint test and dribbling improve after PT and RT compare to the control group ($P < 0.05$). However, changes in time of sprint test and dribbling were not significantly different between two training groups. For accuracy of shooting no significant changes were observed after the PT or RT (Table 2).

Table 2. Time of sprint test and dribbling and accuracy of shooting (mean \pm S.D.) of the subjects before and after 8 weeks of PT, RT and control condition.

	Plyometric training		Resistance training		Control	
Repeated sprint test (s)	2.5 \pm 0.1	2.4 \pm 0.1*	2.7 \pm 0.1	2.5 \pm 0.08 [†]	2.6 \pm 0.09	2.6 \pm 0.08
Accuracy of shooting	3.6 \pm 0.9	5.3 \pm 1.4	2.4 \pm 1.2	3 \pm 1.4	2.8 \pm 1.5	2.9 \pm 1.2
Dribble (s)	6.1 \pm 0.4	5.4 \pm 0.3*	6.8 \pm 0.6	6.3 \pm 0.4 [†]	6.7 \pm 0.5	6.7 \pm 0.5

* Significant difference ($P < 0.05$) between PT and control trials

† Significant difference ($P < 0.05$) between RT and control trials

DISCUSSION

The purpose of this study was to determine if PT or RT can enhance sprint and skill performance in young soccer players. The results showed that both PT and RT significantly improved sprint performance, but there were no significant difference between the two groups (4% and 7.4% respectively). Fry et al. (1991) and Wilson et al. (1993) reported no significant increase in sprint acceleration or velocity after PT and RT in trained subjects [7,20]. This may be related to the lack of specific sprint training during the intervention period. Furthermore, it has been reported that strength training not always improves 20m-100m sprint time [9,11,20]. The group in the study of Kotzamanidis et al. (2005), which performed sprint training in addition to strength training, improved their 30m-sprint performance while the group who had no sprint training did not improve [9]. Similarly, in the study of Delecluse et al. (1997) there was a significant increase in sprint acceleration when strength and sprint training was combined [6]. It seems that the concurrent sprint training (performed during the regularly soccer practices) in the present study may be important for sprint adaptations. This is in line with other studies on professional soccer players, which found that concurrent heavy RT, PT and soccer session increased the sprint performance [8,17]. Another possible explanation for the improved sprint performance in the current study may be the inclusion of a specific hip flexor exercise in the PT and RT, shown to relate to improvements in sprint performance [6].

The results showed that the time of dribbling improved after PT and RT, but there were no significant difference between the two groups (11.4% and 7.3% respectively). Agility refers to the capability to change the direction of the body abruptly, thus it seems that there is a positive relationship between agility and dribbling performance. Although, there was no study was to determine the effects of PT or RT on the dribbling in the soccer players, but the previous studies reported that the skill of dribbling had a positive correlation with speed and agility on other sports

[3,16]. In a previous study of PT, the authors speculated that improvements were a result of enhanced motor unit recruitment patterns [15]. Neural adaptations usually occur when athletes respond or react as a result of improved coordination between the CNS signal and proprioceptive feedback [5]. However, we could not determine if neural adaptations occurred via synchronous firing of the motor neurons or better facilitation of neural impulses to the spinal cord which also supports the suggestions of Potteiger *et al.* (1999) [15]. Therefore, more studies are needed to determine neural adaptations as a result of PT and how it affects agility. Roper (1998) and Miller *et al.* (2006) stated that the relationship between PT and increased performance in agility tests may be high due to their similar patterns of movement to facilitate power and movement efficiency by the immediate change in direction upon landing [12,18]. Our results showed that although 8 weeks PT and RT increase accuracy of shooting, but did not achieve statistical significance. By our knowledge there was no study was to determine the effects of PT or RT on accuracy of shooting in the soccer players. It seems that the adaptations consequent of PT and RT not effected on skill of accuracy of shooting. Additional research is needed to examine the effects of PT and RT on the accuracy of shooting in the soccer players.

CONCLUSION

In summary, although the time of sprint running test and dribbling improve after PT and RT, these training have not effective to improve accuracy of shooting in young soccer players. Additional research is needed to examine the effects of PT and RT on the accuracy of shooting in the soccer players.

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