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Comparison of the Effect of Plyometric and Resistance Training on Explosive Power and Speed in Female Taekwondo Players

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ABSTRACT

In competitions, athletes usually experience situations where they have to compete against stronger or faster individuals or teams. Plyometric and resistance exercise trainings contribute to athletes' power and speed. The present study aims to compare the effects of plyometric and resistance exercise trainings on crural explosive power and speed in young female Taekwondo players. A number of 20 Taekwondo players (Age=20.4±1.6 yrs) volunteered to participate in the study. The subjects were randomly assigned into either a plyometric or a resistance training groups. Either group participated in a 6-week training program, three sessions a week. Kolmogorov-Smirnov and t-student tests were run to examine the normality of the data and to compare the mean scores of the two groups, respectively ($P<0.05$). The results showed no significant difference between the effect of plyometric and resistance trainings on crural explosive power and speed in young female Taekwondo players. Research has shown that neuromuscular coordination, reflective electrical activity, increased muscular contraction speed and using more motor units result from either training method, which might have improved crural explosive power and speed in Taekwondo players. Still, considering the similar effects of plyometric and resistance trainings, it is recommended that either method be used consistent with facilities and the principle of training diversity.

KEYWORDS: plyometric training, resistance training, explosive power, speed, Taekwondo player

INTRODUCTION

A variety of studies is being conducted on physical education and sports sciences in the world. Some studies investigate the effect of different training programs on physical abilities. These studies typically aim to examine what training program may improve what physical skills in athletes. In principle, exercise training increases motor skills in human. In this regard, it is crucial to set up proper training programs consistent with motor needs and physiological properties of every sport. Jumping speed and power are invariably considered as significant factors in performing many sport skills [1]. Sport experts suggest that weight training and plyometric workout are two training methods that improve athletes' power and skills [2]. From among modern training methods, greater attention has paid to muscular fitness exercises. Plyometric exercises hinge on a set of mechanical and physiological skills and abilities [3]. Plyometrics is a type of explosive training that was first used by Russian athletes in 1960 summer Olympics [2]. Plyometric training was established by Russian coach, Yuri Verkhoshansky, who used this type of training with jumpers [4]. Plyometrics is a type of neuromuscular training used to increase power or explosive power, which enables athletes to use their maximum power in minimum time [5]. Voluntary and involuntary motor processes involved in plyometric exercises are characterized by stretch reflex. Fusiform system and stretch reflex are two important elements of nervous system exercising a comprehensive control over body. Plyometric exercises are developed to make changes in neuromuscular system and improve muscle group abilities in providing fast and powerful responses to quick but slight changes in muscle length [1].

Since most muscular contractions are of concentric type in speed and explosive sports, which requires neuromuscular coordination, plyometric exercises can be used to increase concentric contraction power and neuromuscular contraction. Research has shown the positive effect of plyometric exercises on athletic performance in different sports [3]. Besides, resistance exercises create great coordination in neuromuscular system [6]. In historical terms, strength exercises denoted the power volume and the size of muscles; however, they have recently been used to increase power, speed, muscle firmness and tone as well as to maintain muscular performance [7]. Weight training may increase power. Research has shown 25-100 percent increase in muscular power following three to six months of training [6].

Speed and power are two major determinants of athletic fitness and performance, which play a key role in most sports. Therefore, an appropriate training program to increase speed, agility and explosive power can be a prerequisite for coaches and athletes' success [8]. On the other hand, improved strength or explosive power is an important component of improved athletic performance, obtained by multiplying strength by momentum [6].

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Several researchers have drawn upon plyometric exercises in their training protocols to improve athletes' physical abilities. They have shown that plyometric workout may improve muscle strength and explosive power [9, 10]. Campo et al. (2009) investigated the effect of plyometric training on explosive power and shooting speed in female soccer players. They reported that experimental subjects showed a significant improvement in jumping ability and shooting speed following 6 and 12 weeks of training, respectively [8]. Kotzamanidis (2006) reported that plyometric training improved jumping performance and running speed in pre-puberty boys [11]. Zidon & Bird (2004) showed that doing plyometric exercises for eight weeks, two sessions per week, could improve athletes' explosive power [12]. Ronnestad et al. (2008) investigated the effect of short-term plyometric and strength trainings on crural speed and explosive power in professional soccer players [13]. The present study aims to investigate and compare the effect of plyometric and resistance training on explosive power and speed in young female Taekwondo players.

MATERIALS AND METHOD

The study adopted a quasi-experimental design. The participants consisted of a number of 20 female Taekwondo players who held black belts and had practiced Taekwondo for at least two years. They volunteered to participate in the study. In order to collect the data, the subjects were asked to complete Par - Q & You Questionnaire first [14]. The subjects then participated in the pretest. Following the completion of the six-week training program, they participated in the posttest.

Participants' height and weight were measured using a stadiometer and a digital scale, respectively. Sargent Jump Test (a test of explosive power) and 60-meter sprint test were administered to the subjects. Then they were randomly divided into either a plyometric training or resistance training group each containing 10 subjects. Subsequently, two muscular strength tests were administered to the plyometric subjects including a one-bout squat test at 1.5 times body weight and a five-bout squat test at 60% body weight for five times in five seconds. As for resistance subjects, maximum strength of quadriceps and twin muscles were tested in standing on tiptoes while maximum strength of hamstring muscles was tested in knee bending. Then the subjects in either group participated in a 6-week training program, three sessions per week, based on the schedule developed for each group. Following the completion of the training program, the participants took Sargent Jump and 60-meter sprint tests again as the posttest [1, 15, and 16].

Due to the high intensity of plyometric exercises in the first week, heavy training was avoided in the first week so that the subjects did light exercise such as Hopscotch, in-situ jumping and other simple leaping exercises. From the third week on, four jumping exercises were introduced to the plyometric group including depth jump, cone jump, box jump and hurdle jump. The intensity of plyometric exercises was controlled through increasing height, distance and repetitions. As for weight training, the training program involved exercises with explosive properties. To this end, the training program developed by Wilson et al. (1993, 1996) was adopted in the present study. The weight training exercises included leg press, knee flexion, knee extension and standing on tiptoe. The exercises were performed in three bouts each with 8, 10 and 6 repetitions at 50, 40 and 30 percent maximum power, respectively, for less than 10 seconds. The training intensity was increased at the beginning of every week [17, 18].

Statistical methods

Kolmogorov-Smirnov test was run to examine the normality of the data. Levene's test and independent t test were run to examine the homogeneity of variances and compare the mean scores between the groups, respectively ($P<0.05$).

RESULTS

The results showed that weight exercise training and plyometric exercises exerted a significant effect on 60-meter sprint time and crural explosive power in the young female Taekwondo players ($P<0.05$). There was no significant difference between the effect of resistance and plyometric exercise training on 60-meter sprint time and crural explosive power ($P>0.05$).

Table1. Subjects general characteristics (N=10)

Variable	Training Group	M±SD	Min	Max
Age (yr)	plyomeric	20.20± 1.50	18	23
	resistance	20.60± 1.80	18	24
Height (cm)	plyomeric	157.60± 2.90	155	163
	resistance	159.90± 3.90	159	167
Weight (kg)	plyomeric	53.67± 4.70	48.3	63.3
	resistance	55.52± 3.90	41.8	63.7

As shown in Table 1, the anthropometric characteristics of plyometric subjects included: Age=20.20±1.5 yrs, Height=157.60±2.9 cm and Weight=53.67±4.7 kg. The anthropometric characteristics of resistance subjects included: Age=20.60±1.8 yrs, Height=159.90±3.9 cm and Weight=55.52±3.9 kg.

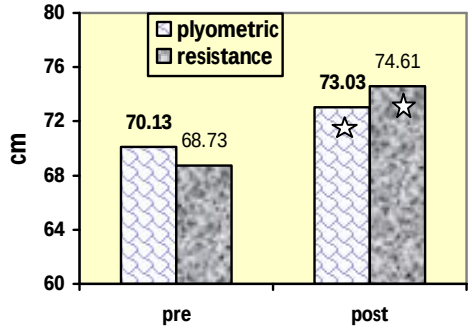

Fig 1. mean of height sarjent jump in subjects

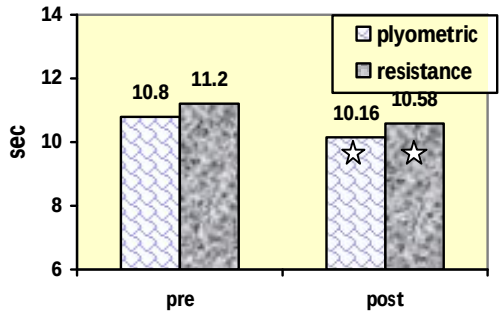

Fig 2. mean of time 60 m sprint in subjects

Table2. Comparison of subject's explosive power & speed in two groups (df=18)

Variable	Training Group	Mean diff Pre &post	Variance of mean diff	t-Val	p-Val
Sarjent jump (cm)	plyometric	2.90±0.27	2.98±0.25	0.426	0.612
	resistance	5.88±0.42			
60 m run (sec)	Plyometric	0.64±0.01	0.02±0.01	0.108	0.211
	resistance	0.62±0.02			

As illustrated in Table 2, the t score of explosive power is 0.426 at 0.612 level of significance which is greater than 0.05. Therefore, there is no significant difference between the effect of plyometric and resistance training on participants' explosive power (P>0.05). The t score of speed is 0.108 at 0.211 level of significance which is greater than 0.05. Therefore, there is no significant difference between the effect of plyometric and resistance training on participants' speed (P>0.05).

DISCUSSION

The present study aimed to investigate and compare the effect of plyometric and resistance training on explosive power and speed in young female Taekwondo players. The results revealed that plyometric training had a significant effect on participants' explosive power. In this regard, plyometric exercises improved explosive power and jumping speed in the subjects. When performed at maximum power, plyometric training increases muscular power [19]. Through decreasing the time interval between eccentric and concentric contraction stages in the stretch-contraction cycle, plyometric exercises increase the muscle contraction speed that is an important factor in explosive power [3, 20]. Therefore, plyometric exercises considerably improve explosive power. This is consistent with the findings of Campo et al. (2009), Zidon and Brid (2004), and Thomas et al. (2008) [8, 12, and 21]. Zidon and Brid (2004) showed that eight weeks of plyometric training, two sessions per week, increased explosive power in the athletes [12]. Campo et al. (2009) investigated the effect of

plyometric exercises on explosive power in female soccer players. They reported a significant improvement in the players' jumping power following six weeks of training [8]. Thomas et al. (2008) studied the effect of plyometric training on explosive power in young soccer players. They reported that plyometric exercises improved explosive power in soccer players [21]. This is consistent with the findings of Kotzamanidis (2006), Avery et al. (2007), Chimera et al. (2004), Wang et al. (2005) and Reyment (2006) [11,22,23,24,25].

The present findings showed that resistance exercise (weight exercise training) significantly improved explosive power in the young female Taekwondo players. Weight exercise training improved posttest explosive power in the subjects comparing with the pretest results. In weight exercise training, initial strength improvement depends on two factors: involvement of more motor units in each contraction and provocation of nerve impulses that activate more motor units in turn. Neuromuscular coordination helps athletes improve their power through weight exercise training. Bumpa (2009) contend that increased power in the early weeks of weight training is associated with neuromuscular adaptation [15].

The present findings correspond to the findings of Willson et al. (1993) who reported that weight exercise training at 30 percent maximum power improved explosive power in the athletes [17]. This is consistent with the findings of Wretenberg (1996) and Willson (1993) who reported that weight exercise training at 30-60 percent maximum power improved muscular explosive power in professional weightlifters [18,26]. Matavulj et al. (2001) and Ronnestad et al. (2008) also showed that weight training improved explosive power in the athletes [13, 27]. The results showed that plyometric exercises significantly improved 60-meter sprint in young female Taekwondo players. Since plyometric exercises change the speed of eccentric and concentric contraction stages in stretch-contraction cycle, improvements in these two stages may result in decreased time interval between eccentric and concentric contractions. Consequently, plyometric exercises increase athletes' speed [28]. Various studies have reported the significant effect of plyometric exercises on running speed. Solonikidis and Zafeiridis (2008) investigated the effect of plyometric exercises on speed in novice ping-pong players. They reported the positive effect of plyometric exercises on the players' speed [29]. Jumping and leaping in plyometric exercises produce elastic energy in the eccentric contraction stage. The elastic energy, produced in the muscles due to gravity and body weight, is consumed during concentric contraction stage. Improved elastic power eventually results in decreased performance time and increased speed [30]. It seems that increased speed and reduced running time due to plyometric exercises are associated with neuromuscular adaptations as well as speed variations in the eccentric and concentric contraction stages. The present findings are consistent with the findings of Campo et al. (2009), Kotzamanidis (2006), Lock wood and Brophyey (2004) and Kubok (2007) [8, 11, 31, 32].

Considering the significant effect of the training protocol on running speed, one may not deem speed as a totally genetic characteristic because the six-week training program was found to increase speed in the athletes. Training may improve and reinforce the performance of nervous system. Weight exercise training may increase the transfer speed of the messages from muscle to nerve and vice versa. This may increase the transfer speed when the stimuli are converted into nerve currents and accelerate nerve currents from efferent neurons to muscles. This may decrease the performance time, hence increased speed. Ronnestad et al. (2008) investigated the effect of plyometric and resistance exercises on speed in professional soccer players. They reported that the training improved the players' speed in both plyometric and resistance groups [13]. Lyttle et al. (1996) showed that strength exercises exerted a significant effect on the athletes' speed [33].

Conclusion

The present findings revealed that both plyometric and weight resistance training improved crural explosive power and running speed in young female Taekwondo players. Therefore, coaches and athletes may use both plyometric and weight exercise training in sports that require high speed and explosive power. As there was no significant difference between the effect of either training method on research variables, plyometric exercises may be used instead of weight exercise training when weights or workout equipment are not available.

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