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Comparison of the Effect of Plyometric and Weight Training Programs on Vertical Jumps in Female Basketball Players

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Abstract: The aim of this study was to compare the effect of combined exercises (plyometric and weight training) on vertical jump of female basketball players. Out of 35 basketball players who competed in first division league of Tehran clubs, 16 players (age: 20.38±3.7 yr, weight: 65.5±11.5 kg and height: 174.78±6.23 cm) participated voluntarily in this study. They were randomly assigned to two experimental and control groups. The experimental group performed plyometric exercises (which consisted of side hop, lay up jump, depth jump) and weight exercises (which included leg press lying, calf raises, leg press standing) 3 days per week for 8 weeks while the control group performed only the vertical jump that was measured with Sargent Jump test. Both groups took part in the pretest and posttest. The accepted level of significant was $p<0.05$. The results indicated the significant effect of combined exercises on vertical jump ($p<0.05$). In addition, the results revealed that the vertical jump of experimental group was significantly greater than control group ($p<0.05$). The results showed that these exercises can also build up foot muscles and increase explosive feet power. Therefore, the application of combined exercises to jumping sports was suggested.

Key words: Combined exercise % Basketball % Plyometric % Weight training % Vertical jump % Explosive

INTRODUCTION

In sports that require jumping and quick movements, there is a need for muscular strength and power [1] such as basketball. One of the basketball skills is rebounding. The player tries to rebound with a quick long jump with outstretched arms as well as the slam-dunk technique that depends on a vertical jump with lots of power. The aim of this study was to increase the vertical jump of female players through combined exercises. The necessity to attain ultimate ability to perform skills has motivated coaches and trainers to apply different solutions and exercises for the success of players. In order to improve in any sport, in addition to necessary knowledge of principles and techniques, the player should have the necessary required fitness. In order to increase vertical jumping, we should pay special attention to the factor of power which is one of the factors of physical fitness. Power is defined as a product of force and velocity or force multiplied by displacement over time [2]. This needs high strength and high speed and in order to improve it, strength and speed should be improved [3]. Some players are genetically endowed with good physical structure, physiology and body composition features. Some of these potentially exist in some players and it is necessary to revive, increase and improve it with suitable planning and special training. The structural and physiological features that affect vertical jumping are the gravitational center of the body and the knee extensor muscles which can help players reach maximum height in jumping [4]. Therefore, this study was carried out on players taller than 170 centimeters; weight training exercises were used to increase muscle strength and plyometric exercises to increase explosive power (strength × speed) [5].

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Polhemus *et al*. (1980) compared two exercise techniques: weight training and combined training of weights and plyometric exercises. This was carried out on two groups of men for six weeks, three sessions a week. After the treatment had been completed, the weight training group increased their vertical jump by 3.3 cm and the combined group demonstrated an increase of 7.6 cm. An identical research was carried out on women in the same year by the above researchers. The weight training groups showed an increase of 3.5 cm and the combined group demonstrated an increase of 10.1 cm [6]. Ford *et al*. (1983) conducted a study on wrestlers and softball players to evaluate the effect of three exercise methods on vertical jumping. These three methods were weight training, weight training and activity and combined exercises of plyometric and weight training. Results showed that combined exercises were most effective [7]. Clutch *et al*. (1983) carried out a research two sessions a week on two groups for sixteen weeks. The first group performed weight training and plyometric exercises which resulted in an increase of 3.57 cm in their vertical jump and the second group who only carried out weight training exercises showed a decrease of 0.11 cm [8]. Bauer *et al*. (1990) studied plyometric and resistance exercises in their research and stated that if plyometric and resistance exercises were used together, they would result in an increase in explosive power [9]. Adams *et al*. (1992) conducted a research to evaluate the effect of squat exercises, plyometric exercises and combined exercises (plyometric and squat) in 3 groups. This study was carried out during six weeks, twice a week. The results revealed that squat exercises resulted in a 3.30 cm increase, plyometric exercises a 3.81 cm increase and combined exercises a 10.68 cm increase in vertical jumps [10]. Duke and Ben Eliyahu (1992) [11] and Fowler *et al*. (1995) [12] in a research compared combined exercises (plyometric and weight training) with weight training alone. The combined method of plyometric and weight training resulted in more improvement of vertical jumps compared to other methods. Kramer, A Morrow and Leqer (1993) [13] assessed the effect of standardized weight training and the effect of the same training with plyometric exercises. The trainings were performed on two groups of female rowers, each of whom had been divided into beginner and advanced sub-groups, totaling in four separate groups. Although experienced oarswomen scored significantly higher than did beginners on 8 out of 12 tests ($p<0.05$), both levels of rowers responded similarly to training. No significant differences were observed in post-training between the S and S+P training programs ($p>0.05$).

William and Ebben (2002) conducted a review research. He concluded that combined weight training and plyometric exercises have shown more increase in jumping than other methods [14]. Kotzamanidis (2005) conducted a research with the purpose of measuring squat jumping through two methods. The first was the resistance method and the second the combined resistance and speed methods. These methods were carried out on two groups of soccer players. He also established a control group for his research. After treatment, he claimed that both experimental groups had improved jumping in comparison to the control group. In addition, the combined exercise group had better results than the resistance exercise group [15]. Rahimi (2006) studied the effect of resistance, plyometric and combined (weight training and plyometric) training methods on vertical jump and anaerobic power and claimed that all three methods resulted in increasing vertical jump and anaerobic power, but combined exercises had more effect on increasing vertical jump and anaerobic power than the other two methods [16]. Perez-Gomez (2008) evaluated the effect of combined weight training and plyometric exercises on some aspects of physical fitness such as vertical jumping and anaerobic capacity in soccer players in a six-week period and stated that after the training period all players showed significant improvement ($p<0.05$) in vertical jumping and anaerobic capacity tests [17].

Trainings, in which the effect of weight training and plyometric exercises has been assessed separately, have been carried out. Tabatabaee (1992) evaluated the effect of plyometric exercises on male basketball players in two control and experimental groups and stated that the experimental group had a significant increase in vertical jumping ($p<0.05$) [18]. Also, Arabi (1994) evaluated the effect of weight training and plyometric exercises separately on two groups of male basketball players. After 21 training sessions no significant difference was found between the two groups in increase of vertical jump, but there existed a significant difference between the pretest and posttest of vertical jumps ($p<0.05$) [19].

It is noteworthy that the effect of a combined weight training and plyometric exercise on the physical ability of Iranian female basketball players, including vertical jump, has not been evaluated so far. Therefore, this study is conducted with the purpose of finding the effect of a period of combined weight training and plyometric exercises on vertical jump of female basketball players.

Table 1: Descriptive characteristics of subjects

Group	Age (years)	Weight (Kg)	Height (Cm)
Experimental Group	21.0±2.0	63.86±4.60	174.5±5.38
Control Group	19.9±4.7	66.78±15.09	175±7.14

MATERIALS AND METHODS

A population of 35 female basketball players who were at least 170cm high and members of one of Tehran's super league teams were invited to take part in the study. Sixteen players participated in the trainings voluntarily. The participants aged between 19 and 23 (Table 1). All subjects were pretested and divided into two groups randomly. The experimental group performed a special training program. After performing the exercises in the given sessions, both samples were posttested.

Plyometric exercises included side jump over benches, depth jumps and lay-up jumps; each of which were carried out as follows: Side jump began over the benches from four jumps and leaded to 11 jumps in 10 sets at the eighth week, over benches with the height of 45 cm and width of 30 cm. Depth jumps were performed with10 jumps a session and the height of the boxes began from 42 cm at the first week and increased to 70 cm at the eighth week. Lay-up jumps started with 6 jumps a session and leaded to 12 jumps at the last week. Weight training included lying leg press, standing leg press and calf workout using Delorm method [20] and workload increased by the overload principle. The subjects had to repeat the third set of the last session of each week as many times as they could. Based on the number of repetitions, the weight was determined for the next week. Weight training exercises were carried out for 25 minutes the first week and 35 minutes the last (or eighth) week.

Weighing scale, tape measure and white powder were used to measure vertical jump. Harman (2008) specifies that vertical jump test is a test in which the standing reach of a subject is measured. The subject then performs a countermovement jump (for the purpose of the study) and marks the wall with chalk at the highest point they reach. By subtracting the standing reach from the height of the jump, you will determine the vertical jump score of the subject [21]. Independent and paired student t test at a significance level ($p<0.05$) and SPSS18 software were used for data analysis.

RESULTS

The descriptive statistics of subjects were calculated and are presented in Table 1.

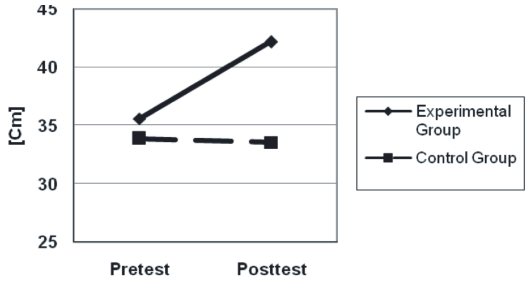

Fig. 1: Vertical jump (cm) in pretest and posttest of experimental and control groups

Table 2: The effect of combined training± program on vertical jump

Group	Test	m±SD (cm)	df	t	D
Experimental	Pretest	35.6±5.06	6	5.96*	0.034
	Posttest	42.2±5.42			
Control	Pretest	33.89±4.59	8	0.08	0.628
	Posttest	33.57±5.12			

*level of significance is $p<0.05$

In order to find out whether the combined training group had made significant improvement, a dependent t test was run. Table 2 shows the effect of the combined training program on the vertical jump of female basketball players in experimental and control groups.

According to data obtained from Table 2, there was a significant difference in vertical jumps of female basketball players between the pretest and posttest of the experimental group. Comparing the average vertical jump of female basketball players in pretest and posttest, the result showed that the experimental group subjects showed significant improvement as a result of combined exercises. It means that the vertical jump of female basketball players in posttest (42.2cm) was more than the pretest (35.6cm). The pretest and posttest of the control group showed no significant difference at P=0.05; there is not a significant difference in the amount of vertical jump of female basketball players of the control group before and after basketball exercises. The mean vertical jumps in pretest and posttest of both experimental and control groups are presented in Figure 1.

Findings also revealed no significant difference in the amount of vertical jump of female basketball players in the pretest. So, it can be concluded that both groups were homogeneous in terms of vertical jumping. In other words, both groups had no significant difference in the beginning of the experiment (Table 3).

The combined training program test on the amount of vertical jump of female basketball players among two experimental and control groups are summarized in Table 4.

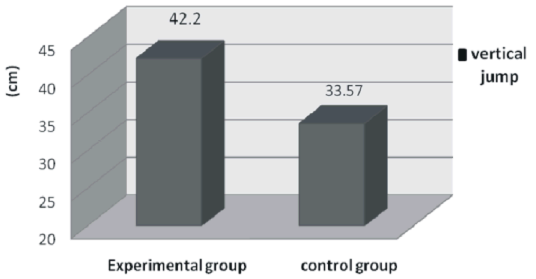

Fig. 2: Comparison of vertical jump in posttest (according to cm)

Table 3: Independent t test results comparing vertical jumps in pretest

Group	m±SD (cm)	df	t	D
Experimental	35.6±5.06	14	0.63	0.749
Control	33.89±4.59			

*Significance level is D <0.05

Table 4: Independent t test results on vertical jump in posttest

Group	m±SD (cm)	df	t	D
Experimental	42.2± 5.41	14	2.194*	0.024
Control	33.57± 5.12			

*Significance level is D <0.05

Table 4 showed that the vertical jump of female basketball players in the posttest of experimental and control groups was significantly different. Comparing the average amounts of the vertical jump of female basketball players in posttest of both experimental and control groups, it can be concluded that the vertical jump of female basketball players of experimental group (42.2cm) was more than the vertical jump of female basketball players of the control group (33.57cm). In other words, the combined training program had a significant effect on the increase of the vertical jump of female basketball players of the experimental group (P=0.024). The comparison of the average amount of both experimental and control groups in posttest are presented in Figure 2.

DISCUSSION AND CONCLUSION

According to the results obtained, the chosen combined weight training and plyometric exercises have a significant effect on vertical jumps and leads to an increase in the amount of the participants' jump. It should be mentioned that all subjects were selected from 12 professional teams of Tehran clubs and no research has yet been carried out using such sample. The results show that the method used in this study demonstrates a higher increase in comparison with other training methods such as weight training and plyometric exercises, which are performed on men who are more muscular than women. The vertical jumps of the experimental group of this research showed an increase of about 7cm at the end of the training period. However, in Tabatabaee (1992) research, the effect of plyometric exercises resulted in a 4 cm increase [18]. In Arabi (1994) research, the effect of weight training and plyometric exercises was assessed separately after the end of training. This study showed a 4.85 cm increase in weight training and a 3.57 cm increase in plyometric exercise method [19]. In addition, more research has been conducted to compare different training methods with combined exercises. Polhemus *et al*. (1980) applied two training methods, combined exercises (weight training and plyometric exercises) and weight training, on two groups of men and stated that the combined training group demonstrated more increase in vertical jumps. The same study in the same year was applied on women, the results of which were similar to men [6]. Clutch *et al*. (1983) conducted a study on two experimental groups. The first group carried out the combined exercises and the second one performed only the weight training. Eventually, the combined exercises showed more increase in vertical jumps [8]. Duke and Ben Eliyahu (1992) [11] and Fowler *et al*. (1995) [12] also showed in a study in which the combined exercises (weight training and plyometric exercises) were compared to single weight training, that the combined training method resulted in more improvement in vertical jumps compared to weight training method.

A number of more comprehensive studies in which three different methods of training (plyometric, weight training and the combination of both) were employed on three groups were carried out by Ford *et al*. (1983) who claimed that the combined method group showed more increase in vertical jumps than plyometric or weight training groups [7]. In addition, Adams *et al*. (1992) conducted a research to evaluate the effect of squat, plyometric and combined exercises on three training groups. The results showed that the combined exercises had nearly an increase 3 times as much as the amount of the two other methods [10]. Rahimi (2006) in his research studied anaerobic power in resistance, plyometric and combined training methods and stated that the combined training method increased anaerobic power more than the other two methods [16]. This is important due to the fact that the basic factor in higher jumps is the anaerobic power of an individual. Therefore, the more the anaerobic power, the higher the jump.

The results of these studies indicate the higher increase of vertical jumps of participants of the combined exercise group compared to the other training methods which are entirely in line with the results of the present study. It can be concluded that this increase is probably due to the strengthening of leg muscles and boosting instant energy resources. In view of the fact that power is a combination of muscle strength and speed, applying such exercises boosts power. The importance of power is because it is influential in increasing vertical jumps. Jumping is of importance in many sports, especially in basketball, in which the difference of less than a centimeter of height can lead to the loss of the ball and failure. This shows why performing these exercises are of great importance in such sports.

The results obtained illustrate the significant effect of combined exercises on vertical jumps and therefore the success of athletes. It is recommended that this exercise method be used with precise planning and adequate study in teams where anaerobic power and vertical jumps lead to their success.

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