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The Effect of Pliometric Training on Some Physical and Physiological Parameters

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Abstract

The aim of this study was to determine the effects of 8-week plyometric training on amateur footballers on some physical and physiological parameters. 24 male amateur football players aged 21.5±2 years, height 182.1±8.84 cm and 82.5±12.4 kg participated in the study. In addition to the regular team training, the experimental group had standardized plyometric training for 8 weeks. VO2max, legs strength, vertical jump, Wingate anaerobic, standing long jump, and 30 meters speed tests were applied to the study group. Intergroup and intra-group parameters were analyzed with Two-Way Manova for Repeated Measurements. Post Hoc comparisons of significant values were determined by Bonferroni Test. There was a statistically significant difference in the pretest and posttest values of the experimental group in terms of vertical jump, standing broad jump, 30 meters speed, legs strength and anaerobic power parameters of plyometric training ($p < 0.05$). As a result, it was determined that 8-week plyometric training had positive effects on the performance values of the subjects.

Key Words: Football; plyometrics, strength, anaerobic power, speed.

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INTRODUCTION

Football is one of the most important sports where explosive force is needed. In football, sudden acceleration, changes in direction, sudden stops, the ascent to the head ball and smashing are movements related to anaerobic energy that require explosive force (Akgün, 1989). During the football game, players perform aerobic and anaerobic activities together (Bangsbo et al, 2006). However, aerobic metabolism is mostly used in the football competition. Anaerobic metabolism involves almost all movements that affect the outcome of the competition (Çakmakcı et al. 2019). Some of these movements; such as shooting, short sprinting, jumping, or double struggles Anaerobic metabolism is met by all movements that determine the outcome of the competition, (Aslan, 2012). All football biomotor abilities (coordination, flexibility, speed, agility, strength and endurance) (Akgün, 1992) are the factors that affect forming of performance (Ünlü and Tatlıcı, 2018).

The aim of plyometric training, which is defined as intensive exercise requiring maximal strength, is performed to provide physiological change necessary for elite athletic performance; to reduce contact time with the ground as much as possible while running or jumping. As soon as they fall to the ground, the quadriceps muscle group is contracted and stretched. A tension also occurs in connective tissues and tendons. This leads to potential elastic energy. Likewise, potential elastic energy is generated in cross bridges. This energy is stored during the eccentric contraction and a large force is released by taking advantage of gravitational force when switching to concentric contraction. In plyometric exercises, reflexive (contraction reflex) contraction during contraction of muscle increases (kin 2000). Elastic strength and quick strength are the determinants of performance in sports such as football that require direction change. Athletes use plyometrics to improve elastic strength, jump efficiency, and leg strength (Dolu 1994). The aim of this study is to determine the effect of plyometric training on performance parameters for 8 weeks.

METHODS

A total of 24 male amateur football players aged 21.5 ± 2 years, height 182.1 ± 8.84 cm and 82.5 ± 12.4 kg participated in the study. Experimental and control groups of the study were determined by random sampling method. During the study, both groups had normal team training and the participants in the experiment group were administered an 8-week plyometric training program. Data collection tools prepared for the study were collected by taking a pre-test and post-test measurements before the plyometric training program.

Shuttle run: The 20 m shuttle run test was used to determine the maximum VO2 values of the subjects. The running speed was increased by 8.5 km / h and increased by 0.5 km.s-1 in one minute and 20 m distance round-trip. According to the protocol, a 20 m shuttle run test band was used to determine the operating speed. The test was terminated when the subject did not capture two consecutive signals or discontinued the test. According to the results, VO2max values of the subjects were recorded as ml/kg/ min (Tamer, 2000)

Maximal Leg Strength: Leg dynamometer (Takei Physical Fitness Test-0.300 kg) was used to measure maximal leg strength. The subject was removed on the device, holding his back and head upright, bending his knees at an angle of 115-125 degrees. From the center of the bar attached to the chain, the palms were held down with pelvis bone level and the bar was raised steadily until the legs were raised vertically. Each test was carried out 3 times, resting 60 sec between each trial. Trials were performed with the dominant foot. The highest value was taken out of three measurements (Soslu et al. 2018).

Vertical Jump: The vertical jump was calibrated based on the height of each participant's standing one-arm reach. The participants jumped from both feet with no step in an attempt to touch the highest place possible (Çakmakcı et al.2018). Jump height was calculated by measuring the reached place There was a trial once and then three jumps were followed. The highest jump height was recorded and used in the analyses. (Özer and Kılınç 2012).

Standing Long Jump Test: The subject jumped a long distance from the marked line using a double foot with maximal effort. The distance between the starting line and the nearest track left by the athlete was measured in meters (Sevim, 1997).

30-meter sprint Test: The measurement was carried out with a photocell stopwatch between 0-30 m on a standard 45 m indoor runway and the duration of the run of the subjects was measured. Of the three attempts, the best was recorded. Two minutes of rest was given between each trial (Taşkın et al. 2015).

Wingate Anaerobic Power and Capacity Test: Wingate anaerobic power and capacity tests were performed on the Monark 839E bicycle ergometer. The testing device was a mechanically braked bicycle ergometer. Before the test, the subjects' feet were firmly strapped to the pedals, and the seat height and handlebars were adjusted for optimal comfort and pedaling efficiency. During the rest period, the subjects were instructed to perform the test with maximum intensity. The subjects began pedaling as fast as possible without any resistance after a five-minute warm-up. Then the WAPT was initiated against minimal

resistance. A fixed resistance was applied to the flywheel within three seconds, and the subjects continued to pedal "all-out" for 30 seconds. A computer continuously recorded the flywheel revolutions in five-second intervals. The flywheel resistance was set at 0.075 kg per kg body weight. The average power was determined by measuring the power outputs observed during the 30 seconds of exercise on a laboratory cycle ergometer. (Soslu et al. 2019; Tatlıcı and Cakmakci 2019).

Application of Plyometric Training: All subjects participated in an 8-week plyometric training program. Jumping training exercises were performed 3 days a week. The intensity of each exercise was maximum and the number of sets and repetitions were changed daily. Plyometric exercises included 2-legged vertical jumps, tuck jumps, 2-legged broad jumps, and depth jumps from a height of 40 cm (Depth Jumps). In all jumping exercises, subjects were instructed to reach maximum heights and to minimize ground contact with restraint and depth jump. The recovery time between repetitions and sets was 15-30 seconds.

A summary of the training program is shown in Table 1. The subjects were instructed not to participate in any physical training they would encounter during their daily activities and to continue their normal diet during the study. At the end of the 8-week training program, subjects were subjected to post-test measurements using the same procedures and programs as during the pre-test (Potteiger et al. 1999).

Table 1. *Summary of Pliometric Exercise Program (Potteiger et al, 1999)*

Movement	Week							
	1	2	3	4	5	6	7	8
Vertical Jumps	5(10)	9(10)	11(10)	13(10)	13(10)	17(10)	17(10)	17(10)
Tuck Jumps	3(30 m)	4(30 m)	3(30 m)	3(30 m)	1(30 m)			
2-Legged Broad Jumps	1(15 m)	2(30 m)	4(30 m)	4(30 m)	4(30 m)	4(30 m)	4(30 m)	4(30 m)
Depth Jumps			1(4)	3(10)	5(10)	5(10)	6(10)	8(10)

Data Analysis

The data obtained from the study were analyzed by using SPSS program for Windows and after 8 weeks training program, differences in values of experimental and control groups were examined. It was seen that the groups showed the normal distribution and provided homogeneity of variance. Intergroup and intra-group parameters were analyzed with Two-Way Manova for Repeated Measurements. Post Hoc comparisons of significant values were determined by Bonferroni Test. The level of significance was accepted as $p<0.05$.

RESULTS

Table 2. *Experiment-Control Group Pre-Post test Vertical Jump (cm) values*

Groups	N	Mean	S.S.	t	p
Experiment pre	12	46,15	5,08	-6,149	0,001*
Experiment post	12	50,02	4,86		
Control pre	12	47,18	4,89	-2,129	0,066
Control post	12	48,22	4,72		
Experiment post	12	50,02	4,86	3,377	0,001*
Control post	12	48,22	4,72		

***:**($p<0,05$)

There was statistically significant differences in the vertical jump (cm) parameter compared to the pre and post-test of the experimental group and the pre and post-test of the control group ($p<0,05$). There was no significant difference between the pre and post-tests of the participants in the control group and the pre-tests of the experimental group ($p> 0.05$).

Table 3. *Experiment-Control Group Pre-Post test Standing Long Jumps (cm) values*

Groups	N	Mean	S.S.	t	p
Experiment pre	12	192,36	11,23	-3,387	0,001*
Experiment post	12	211,25	10,34		
Control pre	12	189,25	10,94	-3,256	0,223
Control post	12	188,87	10,02		
Experiment post	12	211,25	10,34	2,113	0,000*
Control post	12	188,87	10,02		

***:**($p<0,05$)

When Table 3 is examined; There were significant differences between the standing long jump (cm) values of the experimental group before and after training ($p<0.05$). Significant differences were also found between the pre-tests of the experimental and control groups ($p<0.05$).

Table 4. *Experiment-Control Group Pre-Post test Vertical 30 Meters Speed Test (sec) values*

Groups	N	Mean	S.S.	t	p
Experiment pre	12	3,78	0,18	4,981	0,248
Experiment post	12	3,72	0,14		
Control pre	12	3,62	0,22	-2,115	0,642
Control post	12	3,78	0,16		
Experiment post	12	3,72	0,14	-0,679	0,625
Control post	12	3,78	0,16		

When Table 4 is examined; No statistically significant difference was found between the pretest and posttest 30 meter speed test (sec) values of the experimental and control groups ($p<0.05$).

Table 5. *Experiment-Control Group Pre-Post test Leg Force (kg) values*

Groups	N	Mean	S.S.	t	p
Experiment pre	12	74,12	12,55	-5,803	0,000*
Experiment post	12	80,25	15,02		
Control pre	12	73,14	12,89	-3,802	0,031*
Control post	12	77,02	13,68		
Experiment post	12	80,25	15,02	3,482	0,022*
Control post	12	77,02	13,68		

***:**($p<0,05$)

When Table 5 is examined; There was a statistically significant difference between the pre-test and post-test of the experimental group, the pre-test and post-test of the control group and the post-test of the control, the post-test of leg strength of the experimental group ($p<0.05$).

Table 6. *Experiment-Control Group Pre-Post test VO2max (ml / kg / min) values*

Groups	N	Mean	S.S.	t	p
Experiment pre	12	49,48	4,50	-3,728	0,001*
Experiment post	12	52,15	3,98		
Control pre	12	48,12	3,12	-3,728	0,402
Control post	12	48,65	3,55		
Experiment post	12	52,15	3,98	4,876	0,001*
Control post	12	48,65	3,55		

***:**($p<0,05$)

When Table 6 is examined; There was a statistically significant difference between the pre-test and post-test VO2max (ml/kg/ min) of the experimental group. Additionally, there was a significant difference in post-tests of the VO2max (ml /kg/min) of the experimental group and the post-test of the control group ($p<0.05$). However, when the differences between the pre- and post-tests of the control group were examined, no significant differences were detected ($p<0.05$).

Table 7. *Experiment-Control Group Pre-Post test Anaerobic Peak Power (watt) values*

Groups	N	Mean	S.S.	t	p
Experiment pre	12	858,22	152,18	-6,184	0,020*
Experiment post	12	886,12	122,14		
Control pre	12	878,24	148,34	-5,629	0,256
Control post	12	882,65	136,12		

Experiment post	12	886,12	122,14	3,145	0,118
Control post	12	882,65	136,12		

***:**($p<0,05$)

When Table 7 was examined, a statistically significant difference was found between the anaerobic peak power parameter of the experimental group of pre-test and post-test performance ($p<0,05$).

DISCUSSION and CONCLUSION

In plyometric exercises, reflexive (contraction reflex) contraction during contraction of muscle increases (Kin, 2000). Elastic strength or quick strength is the determinant of performance in sports such as football that require direction change. Athletes use plyometrics training method to gain elastic strength, jump efficiency, and leg strength (Dolu, 1994). Ateş et al. (2007) found a statistically significant difference in anaerobic power (Cooper test), flexibility, speed of 30 m, aerobic power and jump in pre-and post-test plyometric training performed on 12 experimental and 12 control groups for 10 weeks. Ateş and Ateşoğlu (2007) obtained a statistically significant difference in the values of vertical jump, leg and back strength, right and left arm pushing power, chest throwing values in the pre and post-test results of the plyometric training applied to football players. Wilson et al. (1996) in their study in the plyometric exercise group lower extremity eccentric force production values increased and Toumi et al. (2004) stated that the increase in maximal isometric strength and maximal concentric strength increased.

Kızılet (2011) showed a statistically significant difference in coordination and standing long jump, 10-30 m sprint and acceleration speed, and repeated sprint time values negatively after plyometric training applied to female players. Göktaş, (2019) showed a statistically significant difference in flexibility, agility, back, leg, arm strength, vertical jump, balance, standing long jump and handgrip strength values as a result of 8-week plyometric training applied to football players. Sayar (2018) found a statistically significant difference in 30 m Sprint, Vertical Jump and VO2 maximum values in footballers who had 8 weeks of agility and plyometric training. Wagner and Kocak, (1997) 's plyometric training designed over 10 weeks after the participants' 0-30, 10-20 and 20-30 meters between the running speed was found to be a significant difference. Kotzamanidis, (2006) study plyometric training applied for 12 weeks after the 25-meter speed test of the experimental group obtained a significant difference. İnce and Dağlıoglu, (2018) showed the difference in Anaerobic Power (kg/sec), speed 30 m (sec) and flexibility (cm) values in plyometric training applied to 11 players and 11 control group players for 8 weeks. Haghighi et al. (2012) showed that there was a

statistically significant difference in the 15 m speed and dribbling values in the 8-week plyometric training preliminary and test results compared to the control group, but there was no difference in the shooting values. Ari and Çolakoğlu (2017) found a statistically significant difference in 12-week plyometric training pre- and post-test anaerobic power, flexibility, speed of 30 m, long jump by stopping. Memarzadeh et al. (2014) obtained a statistically significant difference in pre-and post-test 20m speed, squat vertical jump, standing long jump, 10 m and 30 m after 8 weeks of plyometric training (Ramos et al.2016). Flavio et al. (2018) did not find a statistically significant difference in the 30-meter speed, vertical and horizontal jump values of the plyometric training pretreatment and post-test on football players.

As a result; plyometric training had a positive effect on vertical jump, standing long jump, 30-meter speed, leg strength, and anaerobic power.

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