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Investigation of different training methods integrated into soccer training on body composition and athletic performance

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim The aim of the study is to investigate the effects of 8-week core and plyometric training on body composition and athletic performance in young male soccer players.

Material and Methods 24 young male soccer players participated in the study voluntarily. The subjects were randomly divided into three separate groups: Core training group (CTG), plyometric training group (PTG) and control group (CG). In addition to soccer training two days a week for 8 weeks, the training was applied to the subjects according to the training programs determined. Physical measurements (Height, Body Weight, Body Mass Index, Fat Mass, Lean Mass) and performance measurements (Vertical Jump, Horizontal Jump, Plyometric Jump, 20 m speed, Agility) were made 8 weeks before and after the study. Subject's measurements were analyzed in the SPSS 22 program.

Results The largest percentage and significant difference in agility, speed, vertical jump and plyometric jump parameters was obtained in PTG, while the largest percentage and significant difference in horizontal jump parameters was obtained in CTG. While no difference was found in speed and agility performance in CTG; there are significant differences in jump performance but these differences are lower than the other experimental groups in terms of percentage difference. On the other hand in body composition, a significant change was observed only in the height parameter in PTG.

Conclusions If a faster improvement is desired in the determined athletic performance parameters in a period of eight weeks in soccer, it may be recommended to prefer core and plyometric trainings in addition to branch training.

Keywords: soccer, core, plyometrics, body composition, athletic performance

Introduction

Being successful in sports is possible today with scientific methods. In order to achieve success in sports, it is aimed to increase the performance of the athlete physically and psychologically with long-term training programming [1]. There are many factors that affect performance in sports. One of the factors affecting the high performance expected from the athlete is the physical structure of the athlete, and this combines with other performance elements such as strength, power, flexibility, speed, endurance and quickness, giving a positive or negative direction to the performance of the athlete [2]. The physical, physiological and psychological characteristics required for the sportive performances expected from high-level athletes have always been among the subjects of interest. For this purpose, extensive and comprehensive studies have been carried out in the literature in order to define the characteristic structures of athletes interested in different sports branches [3, 4, 5]. Soccer is undoubtedly one of the sports research topics that the performances of the athletes are the most curious and focused on. Soccer is a sport that includes high and low intensity movement processes in an aerobic environment in terms of game time. Unlike many other sports in soccer, during a 90-minute soccer match, soccer players perform many explosive movements such as kicking, fighting, jumping, turning, sprinting and changing speed [6]. These movements consist of different technical and tactical skills. With this feature, it is a sport that has physical and physiological competencies that affect performance such as high-level aerobic and anaerobic endurance, strength, flexibility, speed, quickness, balance, reaction. In soccer, coaches want players to be able to perform high-intensity movements in the game in the best way in every part of long playing time. In addition, soccer players must have a strong muscle structure in order to perform better than their opponents and to prevent possible injuries. At this point, core and plyometric training can be counted among the methods most frequently used by trainers. The core region of the body consists of passive and active structures such as muscles, connective tissues (ligaments, tendons), bones that form and surround the pelvis and spinal canal [7]. The greater the core strength of the athlete, the

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greater the power generation in the arms and legs [8]. Core training includes exercises to train the muscles that control and stabilize abdominal, waist and hip movements. Core strength and stabilization play an important role in efficiently transmitting the power generated during an activity from the trunk to the extremities or from the extremities to the trunk. [9]. Therefore, core training will provide some benefits not only for the development of some physiological and motoric features of footballers considering their upper level training and success but also for time and money [10]. Core training is generally preferred to improve an individual's balance, strength, anatomical function, and flexibility [11]. Unlike many other branches, soccer is a sport where many movements must be performed quickly and without planning. As it is known, the magnitude of the explosive force directly affects the jump performance. [12]. Jumping performance is an important part of sportive performance, although it has different importance in sports branches. Soccer is one of these sports branches. Plyometric training includes exercises in which active muscles are stretched before shortening. Plyometric exercise is a type of exercise used to increase the muscle's ability to generate power. Plyometric exercise increases the flexibility of the muscles by using activities such as jumping, jumping and limiting. Plyometric training has been shown to increase jumping ability and power of other explosive movements [13]. In the light of these data, it was aimed to investigate the effects of 8-week core and plyometric training on body composition and athletic performance in young male soccer players.

Materials and Methods

Participants

24 male soccer players aged 17-18 participated in the study voluntarily. This study, which was carried out according to the ethical standards of the Declaration of Helsinki. Approved by the Health Sciences Ethics Committee of Bingöl University.

Research Design

Before the study, the subjects participating in the study were told the necessary details about the research method, and consent forms were filled and signed by the participants and their parents. Those with previous lumbar and lower extremity injuries, cardiovascular disease, and any condition that could affect the exercise process and results were excluded from the study. The subjects were randomly divided into three separate groups: Core Training Group (CTG, n=8), Plyometric Training Group (PTG, n=8), Control Group (CG, n=8). All groups participated in the same soccer training three days a week for eight weeks, while the first group performed eight-week core and the second group eight-week plyometric training programs (Table 1, Table 2). The third group participated in this study as a control group

Table 1. Core training program

Movement Name	First 4 weeks		Second 4 weeks	
	Repetition	Sets	Repetition	Sets
Plank, sec	15	4	15	6
Side plank right, sec	15	2	15	4
Side plank left, sec	15	2	15	4
Crunch on pilates ball, reps	15	1	15	2
Back extension on pilates ball, reps	15	1	15	2
Russian twist, reps	15	2	15	4
Hip raise, reps	15	1	15	2
Dog kick right and left, reps	15	1	15	2

Table 2. Plyometric training program

Movement Name	First 4 weeks		Second 4 weeks	
	Repetition, pieces	Sets	Repetition, pieces	Sets
Horizontal jump	6	2	8	2
Vertical jump	6	2	8	2
Horizontal jump sideways (right)	6	1	8	1
Horizontal jump sideways (left)	6	1	8	1
Lateral bounding	10	2	12	2
Forward leap over a 30 cm obstacle	6	2	8	2
Side jump over 30 cm obstacle (right)	6	1	8	1
Side jump over 30 cm obstacle (left)	6	1	8	1

did just soccer training. Inclusion criteria was determined as being a male soccer player between the ages of 17-18 whose sports age (SA) was at least two years, not having any injury or surgery and not participating any plyometric and core training in the last six months, not being involved in any sports branch other than football training and not miss any practice during the measurement and tests. In the body fat ratio measurements of the subjects; body mass index (BMI), body fat percentage (BFP), lean mass (LM), fat mass (FM), body composition analysis data were obtained. In order to determine athletic performance; 20 m sprint test, Illinois agility test, and within the scope of jump tests, vertical jump (VJ) test, horizontal jump (HJ) test, plyometric jump (PJ) test measurements were applied to the athletes.

Anthropometric Measurements

Height and Body Weight (BW) Measurement: Height was measured to the nearest 0.1 cm using a fixed stadiometer (Holtain, UK) and BW was measured to the nearest 0.1 kg with a standard scale (Medisana, Germany) using a portable balance [14].

Determination of Body Composition: Tanita BC-418 MA body composition analyzer was used.

Performance Measurements

20 m Sprint Test: 20 meter test was used to measure the speed skills of subjects. The subjects started the test 1 meter behind from the starting line and the acceleration and speed values were recorded with the photocells placed 20 meters (Newtest 2000; Newtest Oy, Oulu, Finland).

Illinois Agility Test: The agility performance of the subjects was determined by the Illinois agility test. The starting photocell began test duration when athlete passed starting point of the test. All athletes tried to complete test track as soon as possible. Test duration was automatically recorded with an accuracy of 0.01 seconds by photocell system (Newtest 2000; Newtest Oy, Oulu, Finland) when athlete passed end point of the test. The Illinois test was performed two times with three minutes rest intervals [15].

Vertical Jump Test: The subject stood beside a wall, started from a static standing position, reached up as high as possible with one hand and marks the wall with his fingertips. The jump was preceded by flexing the knees to approximately 90°; the subject jumped up with maximum effort as fast as he could and made a sign on the wall again with the same hand. The difference between these two marks in centimetres was considered as the maximum vertical jump height [16]. Three attempts were made and the best result was recorded.

Horizontal Jump Test: The starting position required subjects to stand with their feet shoulder-width a part behind a starting line and their arms loosely hanging down. On the command ready, set, go, participants executed a countermovement with their legs and arms and jumped at maximal effort in the horizontal direction. Participants had to land with both feet at the same time and were not allowed to fall forward or backward. The horizontal distance between the starting line and the heel of the rear foot was recorded via tape measure to the nearest 1 cm [17]. Soccer players jumped 3 times and the highest score was recorded.

Plyometric Jump Test: In this test, players change places after a kick-off line, taking three steps on the horizontal axis and jumping the furthest. Subjects' hands are on the waist during this test. The subjects moved directly forward without taking a step after the starting line. He lands on the ground with first right, then left, then double steps, and the distance from the starting line to the last place he reached was recorded in cm. Three measurements were taken from the subjects with appropriate rest intervals for this test and the best score was recorded as the test value.

Statistical Analysis

The analysis of the data was evaluated in the SPSS 22 package program. Arithmetic means, within-group mean and standard deviation values have been determined. Comparisons between groups were made with the Paired-Samples T Test. The significance level was determined as $p<0.05$.

Results

Age, sports age, height and BW data for all groups are shown in the Table 3.

Table 3. Characteristics of the subjects.

Variables	Core Training Group (n=8)	Plyometric Training Group (n=8)	Control Group (n=8)
Age (years)	17.2±0.4	17.3±0.5	17.7±0.5
Sports Age (years)	3.5±1.1	3.5±0.8	3.2±0.8
Height (cm)	175.0±7.8	175.8±5.1	179.7±9.8
Body Weight (kg)	76.4±12.4	61.4±4.3	70.7±12.1

After eight weeks of core training, no significant difference was found in the body composition values of the subjects in CTG. After eight weeks of plyometric training, changes in height, fat percentage and FM in PTG were determined to be significantly different. A significant increase was found only in the LM parameter in CG who only did soccer training (Table 4, $p<0.05$).

After eight weeks of core and plyometric training in young male soccer players, in the VJ performance in the groups, in the pre & post tests, respectively; Performance data were obtained with a 7% significant increase in CTG ($p<0.001$), a 13.5% significant increase in PTG ($p<0.001$), and a 3% significant increase in CG ($p<0.05$). The biggest change in VJ performance was observed in PTG (Table 5).

Table 4. Comparison of in-group body composition data of young male soccer players before and after core and plyometric training

Variables	Groups	Pre-test X±Sd	Post-test X±Sd	p
Height (cm)	CTG	175.0±7.8	175.8±8.0	0.500
	PTG	175.8±5.1	177.2±5.6	0.043*
	CG	179.7±9.8	181.7±9.7	0.250
Body Weight (kg)	CTG	76.4±12.4	77.9±13.3	0.111
	PTG	61.4±4.3	62.4±5.5	0.207
	CG	70.7±12.1	69.8±10.9	0.404
Body Mass Index (kg/m^2)	CTG	25.2±5.5	25.9±5.4	0.194
	PTG	19.8±1.2	19.9±1.6	0.712
	CG	21.9±3.7	21.6±3.3	0.352
Fat (%)	CTG	18.7±6.9	17.3±10.3	0.742
	PTG	9.7±2.8	8.0±2.7	0.038*
	CG	14.3±5.7	13.6±6.5	0.458
Fat Mass (kg)	CTG	15.3±8.3	13.4±9.8	0.322
	PTG	6.1±2.1	4.9±2.0	0.026*
	CG	10,4±5.2	10.1±6.2	0.712
Lean Mass (kg)	CTG	62.6±6.6	63.0±5.2	0.822
	PTG	54.4±3.4	56.3±4.8	0.017*
	CG	59.4±7.4	60.6±8.1	0.018*

Note: CTG - Core Training Group, PTG - Plyometric Training Group; CG - Control Group; * - p<0.05

Table 5. Comparison of in-group athletic performance data of young male soccer players before and after core and plyometric training.

Variables	Groups	Pre-test X±Sd	Post-test X±Sd	p
Vertical Jump (cm)	CTG	40.3±10.8	43.2±10.8	0.001**
	PTG	42.3±11.7	48.0±11.3	0.001**
	CG	39.3±3.3	40.3±2.9	0.041*
Horizontal Jump (cm)	CTG	186.8±48.3	194.2±49.9	0.031*
	PTG	178.7±33.1	184.2±33.4	0.010*
	CG	172.2±10.4	173.2±10.8	0.041*
Plyometric Jump (cm)	CTG	564.2±75.3	571.7±75.6	0.031*
	PTG	595.0±75.8	604.3±73.3	0.001**
	CG	600.8±35.4	602.3±36.6	0.017*
20 m (sec)	CTG	3.59±0.34	3.49±0.39	0.031*
	PTG	3.40±0.30	3.21±0.24	0.000**
	CG	3.54±0.33	3.51±0.31	0.107
Agility (sec)	CTG	17.50±1.04	17.01±0.89	0.003**
	PTG	17.55±0.71	16.92±0.60	0.009**
	CG	17.69±0.71	17.60±0.63	0.063

**: p<0.01; *: p<0.05

After eight weeks of core and plyometric training in soccer players, in the HJ performance in the groups, in the pre & post tests, respectively; Performance data were obtained with a 4% significant increase in CTG ($p<0.05$), a 3% significant increase in PTG ($p<0.05$), and a 0.5% significant increase in CG ($p<0.05$). The biggest difference in HJ performance was observed in CTG (Table 5).

In the plyometric jump performance, in the pre & post tests respectively; Performance data were obtained with a 1.3% significant increase in CTG ($p<0.05$), a 1.6% significant increase in PTG ($p<0.01$), and a 0.2% significant increase in CG ($p<0.05$). The greatest change in PJ performance was observed in PTG in the positive direction (Table 5).

At the 20 m sprint performance, in the pre & post tests respectively; Performance data were obtained with a significant decrease of 2.9% in CTG and 5.6% in PTG ($p<0.05$), and a non-significant decrease of 0.8% in CG. In sprint performance, a significant decrease was observed in both PTG and CTG, with a higher rate in PTG (Table 5).

In the agility performance groups, in the pre & post tests respectively; Performance data were obtained with a significant decrease of 2.9% in CTG and 3.7% in PTG ($p<0.01$), and a non-significant decrease of 0.5% in CG. The biggest difference in agility performance was observed in PTG (Table 5).

Discussion

Sadeghi et al. reported that they did not detect any difference in height value in their study in 2013 in which they examined the effects of 6-week core and plyometric training on 11-14 age group boys [18]. In another study, the effect of eight-week core training applied to soccer players on some physical and physiological parameters; In the study in which the study group reported the mean age as 21,52 years, no statistically significant difference was found between the pre-test and post-test results in the height parameter of the subjects. The reason for this was reported as the reason for the lack of significance in these parameters because the study was short-lived and the average age of the athletes consisted of individuals who completed their developmental period [19]. In the literature, it is stated that the growth process should be considered when evaluating physical performance in children and adolescents [20]. When the pre-test and post-test values were compared in the study, it was found that there was a significant increase in the height of PTG among the subjects participating in our study ($p<0.05$). It is thought that the main reason why this difference cannot be the result of the training we have done in a short period of 8 weeks can be explained by the fact that the subjects are in their growing age. Chely et al. did not reveal any significant difference in terms of the body weights of the participants in the 8-week plyometric training conducted with young handball players in the middle of the season [21]. When the body weight values of the subjects were examined in our study, no statistical difference was found as a result of the study. When we look at some studies in the literature, it is reported that plyometric training has no effect on body weight [22, 23]. According to this information, it can be said that plyometric studies have no effect on the body weight of the subjects.

After eight weeks of core training, no significant difference was found in the body composition values of the subjects in the core training group ($p>0.05$). There are not many studies that reveal the effect of core training programs on the body composition characteristics of athletes. As a result of the breakdown of high amounts of calories with training, decreases in body fat percentage ocur [24]. While strength training increases lean body weight with an anabolic effect, studies on sedentary individuals generally have positive effects on body composition, as it causes changes in body composition by decreasing body fat percentage [25; 26] but this effect is not reported in the literature in studies with athletes [27, 28, 29]. Because, considering that the athletes already have certain body composition suitability such as high lean body mass and low fat mass due to their regular training, it can be explained why core stabilization exercises do not cause body composition changes in athletes.

One of the high performance indicators in soccer is the jumping feature. The largest percentage and significant difference in VJ and PJ parameters was obtained in PTG, while the largest percentage and significant difference in HJ parameters was obtained in CTG. While there are significant differences in jump performance in CG who only practiced soccer for eight weeks, these differences are lower than the other experimental groups in terms of percentage difference. As a result of correct strength training, there should be improvement in VJ, HJ and maximal half squat values [30]. In Singh's study examining the effects of plyometric training on adolescent taekwondo players, it is reported that plyometric training significantly increases the VJ height [31]. In a meta-analysis study conducted by Markovic (2007) on plyometric studies, it was observed that plyometric training increased the VJ height and it is argued that plyometric training is an effective physical conditioning method to increase the VJ performance of healthy people [32]. Rahmat et al. reported that the 6-week core stabilization program increased the long jump performance by stopping in 17 children aged 9-12 years [33]. These studies support our study. According to these data, we can say that plyometric training has an improving effect on the jumping feature.

Speed and agility are important features that provide one step closer to the ball in soccer, especially in offensive or defensive positions that will

determine the outcome of the match. In our study, in addition to the improvement in both experimental groups, it was determined that there was more improvement in two features in PTG. In CG, there was no difference in speed and agility performance at the end of eight weeks in athletes. Günay and Yüce found a statistically significant change in the 20m sprint test values in the experimental group after the 8-week core strength training program ($p<0.05$), but did not find any significance in the control group [34]. Fernandez et al. reported that there was a positive and significant improvement in the speed feature of the experimental group in their study in which they examined the effects of 8-week plyometric training on the performance parameters of young tennis players [35]. Michael et al., in their study investigating the effect of plyometric training on agility, reported that there was a significant increase in t-test agility values in the experimental group, but no difference in the control group [36]. Sadeghi et al. reported that there was a statistically significant increase in agility in both core and plyometric training groups in their study examining the effects of 6-week core and plyometric training on 11-14 age group boys [18]. Looking at similar studies in the literature, it seems that the significant change in speed and agility values in our study overlaps with other studies. In this case, it can be said that strength training contributes positively to sprint and agility time.

Conclusions

In this study, it was aimed to examine the effects of eight-week core and plyometric training on body composition and athletic performance in young male soccer players. After eight weeks of core training, a significant difference was determined in all athletic performance values in CTG. After eight weeks of plyometric training, a significant difference was determined in other athletic performance values, except sprint performance, in PTG. While there are minimal quantitative changes in CG who only trains soccer, this difference is not significant in speed and agility performance. However, at the end of eight weeks, a significant difference was found in jump performances in CG. This is thought to be due to regular soccer training.

As a result; If a faster improvement in the body composition and athletic performance parameters of soccer players is desired in a period of eight weeks, core and plyometric trainings are recommended in addition to branch training. When planning the training, it is important to pay attention to the number of repetitions, sets and series to be determined by considering the prerequisites such as the age of the athletes and their strength status.

Conflict of interest

The authors declare no conflict of interest.

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