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THE EFFECT OF CORE STRENGTH TRAINING PROGRAM ON BALANCE AND FLEXIBILITY PERFORMANCE IN YOUNG FOOTBALL PLAYERS

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Abstract:
The aim of this study was to investigate the effects of a core strength training program on balance and flexibility performance in young football players. A total of 20 licensed male football players between the ages of 18 and 21 who were doing regular football training participated voluntarily in the study. Participants were randomly divided into two groups as experimental (n:10, age: 18.80±0.91) and control (n:10, age: 19.60±1.34) groups. The experimental group received a core strength training program in addition to football training 3 days a week for 6 weeks. Both groups continued their normal football training. Balance and flexibility values were measured before and after the core strength training program. Balance performances of the subjects were measured with Star Excursion Balance Test (SEBT) and Flamingo Balance Test (FBT). Flexibility performance was measured with Sit and Reach test. SPSS 22.0 package program was used to obtain statistical results. Shapiro-Wilk test was used for normality test. Paired Samples T test was used for intra-group comparisons and Independent Samples T Test was used for inter-group comparisons. Significance level was determined as $p<0.05$. A positive significance was found in the balance and flexibility values of the experimental group after the core strength training program ($p<0.05$). As a result, it can be said that the 6-week core strength training program applied to young football players has a positive effect on balance and flexibility parameters.

Keywords: core training, balance, flexibility, football, strength

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1. Introduction

Football is one of the most popular sports worldwide (1). Strength, speed, balance, flexibility, mobility, agility, quickness, and both aerobic and anaerobic power are important parameters for successful performance in football players (2).

Strength is considered one of the fundamental elements of performance in football, as in all sports. It can be defined as the ability of the human body to respond to external and internal resistances (3). Strength training includes physical activities aimed at improving an individual's strength parameters. This type of training can be done with free weights or body weight (4). The core training model is also included in strength training. Core exercises reduce the risk of injury in athletes and increase their motor control. Therefore, it allows for energy transfer between movements during physical activity. Due to these and similar effects, the core training model has been added to strength training and football training programs in recent years (5, 6).

Flexibility can be defined as the range of motion up to the optimum limits when one or more joints are involved in the movement (7). Increased flexibility is known to reduce muscle tension and help the body move without pressure. Therefore, it can be concluded that flexibility directly affects all kinds of sports and people's daily life skills (8).

Balance can be defined as the ability to adapt to the displacement of the center of gravity of the body in stationary or moving situations (9). It is necessary to mention the existence of balance in all sports branches, because balance is at the heart of movement-based sporting activities (10).

In light of this information, it becomes clear that systematic and multifaceted development is essential for success in football. It is important to determine the impact of a core strength training program on balance and flexibility performance from the perspective of coaches, athletes, and sports science professionals. The aim of this study is to examine the effect of a core strength training program on balance and flexibility performance in young football players and to provide recommendations for coaches and athletes regarding training planning in football.

2. Methods

2.1. Subjects

A total of 20 licensed male football players aged 18-21 who regularly trained in football voluntarily participated in the study. Participants were randomly divided into two groups: an experimental group (n:10, age: 18.80±0.91) and a control group (n:10, age: 19.60±1.34). The experimental group underwent a core strength training program three days a week in addition to their football training for six weeks. Both groups continued with their normal football training. Balance and flexibility values were measured before and after the core strength training program. Balance performance of the subjects was measured using the Star Excursion Balance Test (SEBT) and the Flamingo Balance Test

(FBT). Flexibility performance was measured using the Sit and Reach test. The subjects were informed about the study method and the rules to be followed. The necessary ethical approval for our study was obtained from the Gaziantep University, Health and Sports Sciences Ethics Committee (20.11.2024/25).

2.2. Training Protocol

In our study, athletes in the experimental group underwent a core strength training program three days a week for six weeks, in addition to their football training. The core strength training program was applied before football training started with a 10-minute warm-up. The experimental group performed core exercises known as Abdominal Crunch, Leg Raises, Mountain Climbers, Russian Twist, Scissor Kicks, Superman, Vertical Leg Crunch, Push Up, Jack Knife, and Bicycle Crunch. In the core strength training program, the exercises were performed at an intensity of 2*15 (sets*reps) for the first 3 weeks and 3*20 (sets*reps) for the last 3 weeks. A rest period of 20 seconds was given between repetitions and 1 minute between sets. The training unit duration was planned to be approximately 60 minutes (11, 12).

2.3. Flamingo Balance Test (FBT)

Static balance of individuals was assessed with the Flamingo Balance Test. The subject stood on a wooden platform (50 cm long, 5 cm high, and 3 cm wide) with one leg and grasped the free leg behind them with their hand on the same side, then tried to maintain balance. They tried to maintain balance as much as possible, first on their right leg and then on their left. The subject could touch the assistant's shoulder to feel balanced. The test was considered to have started the moment the subject released the assistant's arm. The subject was asked to maintain their balance for one minute, and the timer was stopped each time the subject lost their balance. The same procedures were repeated after each pause, and the subject was scored in this way for one minute (13).

2.4. Star Excursion Balance Test (SEBT)

The dynamic balance measurements of the subjects were measured with the Star Excursion Balance Test (SEBT). The SEBT was drawn on the ground with a 45-degree angle, in a total of 8 directions. The subjects were asked to reach in these directions according to a predetermined protocol, and the distance they reached was recorded in cm. The subjects were given 180 seconds to familiarize themselves with the test before the test. A 120-second rest was given between applications. In addition, a 5-second period was given for them to stand on both feet between each reaching movement, and the data was recorded. The test was applied to the dominant and non-dominant leg (14). The formula developed by Gribble and Hertel was used to normalize the data.

Normalized Reach Distance (%) = (Reach Distance / Leg Length) × 100 (15).

2.5. Flexibility Test

The subject was seated on a flat surface with their bare soles touching the test bench. Then, they were asked to stretch their torso forward to the highest possible distance, keeping their arms, legs, and fingers straight. They were asked to hold the highest point for two seconds, and after two trials, the best result was recorded (16).

2.6. Statistical Analysis

SPSS 22.0 software package was used for the statistical analysis of our study's data. The Shapiro-Wilk test was applied for normality testing. Paired Samples T-test was applied for within-group comparisons, and Independent Samples T-test was applied for between-group comparisons. The significance level was set at $p<0.05$. G Power 3.1 software was used to determine the number of subjects participating in the study.

3. Results

Table 1: Age, height, and body weight information of the study groups

Variable	Experimental Group	Control Group
	Mean±SD	Mean±SD
Age (years)	18.80 ± 0.91	19.60 ± 1.34
Height (cm)	177.60 ± 5.29	180.70 ± 5.33
Weight (kg)	69.90 ± 7.21	76.10 ± 4.48
BMI (kg/m^2)	22.10 ± 1.18	23.33 ± 1.56

Note: BMI: Body Mass Index, SD: Standard Deviation

Anthropometric data of the experimental and control groups are presented in Table 1.

Table 2: Statistical analysis results of the experimental group before and after the test (n:10)

Variable	Pre-test	Post-test	t	p
	Mean ±SD	Mean ±SD		
Flexibility (cm)	29.70 ± 5.37	33.40 ± 6.50	-4.832	**0.001***
FBT Right leg	4.10 ± 1.66	2.40 ± 2.06	3.597	**0.006***
FBT Left leg	6.20 ± 5.37	3.10 ± 2.13	2.318	**0.046***
Total SEBT Right leg	697.49 ± 44.51	751.56 ± 45.52	-5.530	**0.001***
Total SEBT Left leg	722.58 ± 47.20	772.21 ± 44.52	-3.520	**0.007***

*p<0.05

Note: FBT: Flamingo Balance Test (Error score), SEBT: Star Excursion Balance Test (Total score).

In Table 2, shows that statistically significant differences were found in flexibility, FBT Right leg, FBT Left leg, SEBT Right leg, and SEBT Left leg measurements after the core strength training program was applied to the experimental group ($p<0.05$).

Table 3: Statistical analysis results of the control group before and after the test (n:10)

Variable	Pre-test	Post-test	t	p
	Mean ±SD	Mean ±SD		
Flexibility (cm)	28.60 ± 4.62	29.70 ± 4.96	-1.819	0.102
FBT Right leg	6.50 ± 3.47	5.80 ± 2.82	1.909	0.089
FBT Left leg	6.20 ± 3.61	5.70 ± 3.05	2.236	0.052
Total SEBT Right leg	712.82 ± 45.07	718.11 ± 47.71	-1.260	0.271
Total SEBT Left leg	706.12 ± 42.32	709.21 ± 43.78	-0.961	0.321

Note: FBT: Flamingo Balance Test (Error score), SEBT: Star Excursion Balance Test (Total score)

In Table 3, shows the analysis results of the pre-test and post-test data of the control group. No statistically significant differences were found in the values of the control group ($p>0.05$).

Table 4: Statistical comparison between groups (n:20)

Variable	Experimental Group Difference	Control Group Difference	t	p
	Mean ±SD	Mean ±SD		
Flexibility (cm)	3.70 ± 2.11	1.10 ± 1.91	2.109	**0.004***
FBT Right leg	-1.70 ± 1.20	-0.70 ± 1.15	-2.650	**0.015***
FBT Left leg	-3.10 ± 4.22	-0.50 ± 0.70	-1.918	0.086
Total SEBT Right leg	54.07 ± 29.19	5.29 ± 7.21	4.578	**0.001***
Total SEBT Left leg	49.63 ± 21.04	3.09 ± 9.74	5.340	**0.001***

*$p<0.05$
Note: FBT: Flamingo Balance Test (Error score), SEBT: Star Excursion Balance Test (Total score).

In Table 4, shows the statistical comparison of the experimental and control groups. Significant differences were found in flexibility, FBT Right leg, SEBT Right leg, and SEBT Left leg measurements in favor of the experimental group ($p<0.05$). No significant difference was found in FBT Left leg measurements ($p>0.05$).

4. Discussion

In our study, a significant improvement in flexibility and balance performance was observed in the experimental group after a 6-week core strength training program ($p<0.05$). No significant difference was found in flexibility and balance performance in the control group ($p<0.05$). The results obtained were compared with the results of other similar studies after a literature review.

Balance, defined as the body's ability to remain stable against the effects of gravity, is important both for everyday life skills and for displaying athletic abilities. Balance ability can be affected by multiple factors. The nervous system, muscle-related components, and visual perception are among these factors (17).

Sandrey and Mitzel (2013) concluded in their study on adolescent athletes that core exercises performed for 6 weeks had positive effects on dynamic balance performance (18). Dinç (2024) 30 karate practitioners examined the effects of 8 weeks of

core training on various parameters and found that core training has a positive effect on dynamic balance (19). In the study conducted by Kaplan et al. (2024), significant increases were found in the balance scores of the experimental group after the core training program applied to wrestlers aged 14-16 years (20).

Our study is similar to studies in the literature. The improvement in balance performance in the experimental group in our study is thought to be related to the dynamic motor control ability that develops along with the increase in overall muscle strength as a result of core strength training.

Flexibility, also considered as range of motion, is known as the freedom to perform movement of the structures around the joint. The structural characteristics of the joint, the structural characteristics of the muscles and bones attached to this joint, the degree of extensibility of the muscle fibers, the internal resistance of the joint, different individual characteristics such as gender and age, and the ligaments around the joint are known as factors affecting flexibility (21). Flexibility is important for the creation and maintenance of athletic performance.

Çamsarı et al. (2024) investigated the effect of core exercises on athletic performance and football technical skills in their study on football players and found significant differences in flexibility parameters as well as in many other parameters in the experimental group (22). In their study conducted on school-aged athletes, Kumar and Zemkova (2022) investigated the effects of core and weight training on muscle strength, endurance, and flexibility. They found that flexibility performance improved more in the core training group compared to the weight training group (23). Dilber et al. (2016) found that core training, applied in addition to football training for 8 weeks, significantly improved flexibility performance in their study on male football players (24).

Our study is consistent with the information given in the literature. It can be said that the flexibility improvement in the experimental group in our study is due to increased intramuscular coordination combined with core strength training.

As a result, it can be said that the 6-week core strength training program applied to young football players has a positive effect on balance and flexibility performance. It is recommended that a regular and systematic core strength training program be implemented in addition to the annual football training plan.

Conflict of Interest Statement

There are no potential conflicts of interest between the authors of this article.

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