AÇIK ERİŞİM
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Gazi Beden Eğitimi ve Spor Bilimleri Dergisi
Gazi Journal of Physical Education and Sports Sciences
2023, 28(1), 63-72

The Effect of Static and Dynamic Core Exercises on Motor Performance and Football-Specific Skills of Football Players Aged 10-12

10-12 Yaş Futbolcularda Statik ve Dinamik Core Egzersizlerinin Motor Performans ve Futbola Özgü Becerilere Etkisi

Research Article / Araştırma Makalesi

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Received / Geliş Tarihi : 25.07.2022
Accepted / Kabul Tarihi : 28.01.2023
Published / Yayın Tarihi : 31.01.2023

Ethical Statement / Etik Bilgilendirme
This research was approved by the Kütahya Dumlupınar University, Social and Human Sciences Scientific Research and Publication Ethics Committee with date 25.12.2019 and number 2019/01

DOI: 10.53434/gbesbd.1148408

Abstract

The aim of this study is to investigate the effect of static and dynamic core exercises on motor performance and football-specific skills in 10-12 year old football players. 60 football players included in the study were randomly divided into three different groups: dynamic, static and control group. Dynamic and static core group athletes were applied core training program in addition to football training, 3 days a week for 10 weeks. Athletes in the control group only continued football training. Pre and post-test measurements of motor performance and football-specific skills have been taken from athletes. Paired-Samples T test was used in the intra-group pre and post-test comparisons regarding the effect of training, and the MANOVA test was used in the intergroup analysis. It was determined that some parameters of the football-specific skill and motor performance values of the athletes a significant differences subjected to static core exercises and the athletes in the control group. A significant difference was found between the pre and post-test values of all parameters of the athletes in dynamic core group. In addition, comparisons between groups at the end of week 10 revealed statistically significant differences in favor of the dynamic core group. As a result, it can be said that additional core training has an effect on football skills and motor performance in children, especially dynamic core exercises contribute significantly to the versatile development of 12 years-old football players.

Keywords: Core training, Football, Strength, Performance, Technic

Öz

Bu çalışmanın amacı, statik ve dinamik core egzersizlerinin 10-12 yaş futbolcularda motor performans ve futbola özgü beceriler üzerine etkisinin araştırılmasıdır. Araştırmaya katılan futbolcular (n=60), rastgele örneklem yöntemi ile dinamik core, statik core ve kontrol grubu olmak üzere üç farklı gruba ayrılmıştır. Dinamik ve statik core grubu sporcularına 10 hafta boyunca haftada 3 gün futbol antrenmanlarına ek olarak kendilerine ait core antrenman programı uygulatılmış, kontrol grubundaki sporcular sadece futbol antrenmanlarına devam etmişlerdir. Sporcuların motor performans ve futbola özgü beceri ölçümleri için ön ve son testleri alınmıştır. Grup içi ön test-son test karşılaştırmalarında Paired-Samples T testi, gruplar arası analizde ise, MANOVA testi uygulanmıştır. Statik core grubu sporcuları ile kontrol grubundaki sporcuların futbola özgü beceri ve motor performans değerlerine ait bazı parametrelerin; dinamik core grubunda ise, tüm parametrelerin ön test–son test değerleri arasında anlamlı farklılığa rastlanmıştır. Gruplar arası karşılaştırmalarda dinamik core grubu lehine istatistiksel olarak anlamlı farklılıklar bulunmuştur. Sonuç olarak, ilave core antrenmanlarının 10-12 yaş futbolcuların futbol becerileri ve motor performansa etkisinin olduğu, özellikle dinamik core egzersizlerinin çocukların çok yönlü gelişimine önemli düzeyde katkı sağladığı, bu bakımdan futbol antrenman programlarına ek olarak kullanılmasının olumlu etkiler yaratacağı söylenebilir.

Anahtar Kelimeler: Core antrenman, Futbol, Kuvvet, Performans, Teknik

Citation / Atıf: Başkaya, G., Ünveren, A. & Karavelioğlu, M. B. (2023). The effect of static and dynamic core exercises on motor performance and football-specific skills of football players aged 10-12. _Gazi Journal of Physical Education and Sports Sciences, 28_(1), 63-72.

Introduction

The core can be defined as the integrity of muscle groups that form the body, support and surround the spine, and play an active role in lower and upper extremity strength transitions (Boyacı, Tutar & Bıyıklı, 2018), and the core foundation consists of more than 20 muscles connected to the lumbopelvic-hip complex (Bıyıklı, 2018). The core can be thought of as the kinetic link that facilitates the transfer of torques and angular momentum between the lower and upper extremities that is of vital importance for sport-specific and everyday activities in different age groups (Granacher, et al., 2014). The core region is considered the centre of the kinetic chain (Sever, 2016), a model that describes the body as an inter-segmental interconnected system that operates sequentially from proximal to distal to produce the desired activity in the distal segment (Kibler, Press & Sciascia, 2006). An effective core "transfers and controls strength and movement in functional athletic performance" in addition to providing optimum power generation (Akuthota & Nadler, 2004; Bıyıklı, 2018). Therefore, strengthening core muscles is a crucial factor for improving performance (Boyacı, et al., 2018). In addition, a good core area allows the athlete to both load more and perform technical movements more efficiently and better (Bilici & Selçuk, 2013; Egesoy, Alptekin & Yapıcı, 2018). Core trainings have been widely used by trainers recently in order to improve game performance of football players (Afyon, 2014b). In addition, scientists also examined the effects of core training on vertical jump, standing long jump, sprint, agility, back and leg strength, right and left hand grip strength, balance, flexibility, plank, sit-up and medicine ball throw performances of young and adult football players (Afyon, 2014a; Afyon, 2014b; Afyon, 2019; Afyon & Boyacı, 2016; Afyon, Mülazımoğlu & Boyacı, 2017; Bashir, Nuhmani, Dhall & Muaidi, 2018; Dilber, et al., 2016; Doğan, et al., 2016; Imai, et al., 2014; Mendeş, 2016; Prieske, et al., 2015) and they found that core muscle training improved some or all of the performance parameters in the study. Recently included children in the study group (Bayrakdar, Kılınç Boz & Işıldar, 2020; Boyacı & Afyon, 2017; Boyacı & Bıyıklı, 2018; Boyacı & Tutar, 2018; Boyacı, et al., 2018; Turna, 2020).

There are some important stages in the psychomotor development of children. Sports-related movements and special movement skills periods, which cover the 7-12 age range, are included in these stages and at this stage, a significant increase occurs in the physical and motor development levels of children (Hekim & Hekim, 2015). It is called the ideal age for learning motor skills. Between 10 and 11-12 years of age for girls and between 10-13 years of age for boys is the period when motoric learning is at its best (İnan, 2012). In particular, sprint, aerobic endurance and agility develop (Diker, 2013). Performance is expected to increase with the development of features such as reaction time, strength, movement speed and balance (Aksoy, 2018; Cerrah, 2013). In addition, this age is also a suitable age for the development of coordination and technique without ignoring fitness (İnan, 2012). Sports scientists have also found that strength training, which is one of the important issues in football, is effective in the strength development of children and in the transition period from childhood to adolescence (Bıyıklı, 2018; Boyacı & Tutar, 2018). In addition, it has been argued that strength training is necessary in children and adolescents to increase athletic success (Bağcı, 2016). According to Aşçı (2011), core training is a very good method to increase the strength of muscle groups in football players aged 14 years and younger. On the other hand, it is assumed that presenting a training method that contributes to the development of branch-specific technical skills as well as the development of motor performance in children will be of great importance in terms of contribution to the field.

The limited number of studies on the effect of core training on motor performance development of football players aged 10 to 12 years and the lack of studies showing its effects on football-specific skills have made studies in this area important. Furthermore, the results of such scientific studies will rapidly increase development in this area. It is anticipated that the results will guide the training plans of trainers, and it will be important to consider the effects of static and dynamic core exercises separately. In this direction, the aim of this study is to demonstrate the effects of static and dynamic core exercises on football skills and motor performance in football players aged 10-12 years.

Methods

Study Group

The study was carried out on a total of 60 football players who competed in the U11, U12 and U13 categories of amateur football leagues and who had at least 3 hours of training and one competition per week in accordance with the training plan. It was determined that the athletes did not have any injuries that could affect the study during or before the study by obtaining the approval of themselves and their coaches, and all of the athletes participated in this study voluntarily and with the permission of their parents. The athletes who participated in the study were divided into 3 different groups as dynamic core group (DCG) (n=20), static core group (SCG) (n=20), and control group (CG) (n=20) (Table 1).

Table 1. Descriptive information of the participants

Variables	DCG (Mean±SD)	SCG (Mean±SD)	CG (Mean±SD)
Age (years)	11.40 ± 0.82	11.55 ± 0.61	11.35 ± 0.49
Training age (years)	3.95 ± 1.19	3.15 ± 1.48	3.05 ± 0.95
Height (cm)	155.30 ± 8.54	151.15 ± 7.71	148.85 ± 6.25
Body weight (kg)	44.56 ± 8.04	40.90 ± 6.21	41.88 ± 8.28

DCG: Dynamic core group, SCG: static core group, CG: control group

Training Program

In the study, 12 core strength-enhancing movements (6 dynamic, 6 static) were selected based on the literature, which were suitable for the age group of the participants in the sample, simple and uncomplicated, and the program was created (Bıyıklı, 2018; Boyacı & Bıyıklı, 2018; Boyacı, et al, 2018; National Academy of Sports Medicine, 2012). The applications were applied to the athletes on the artificial turf football field by the researcher, who has a certificate as an athletic performance trainer, for approximately 30-35 minutes (including warm-up) in addition to football trainings for the specified period of time. The principle of increasing load was observed when determining the application times (Bompa, 2011), Adequate rests for loading were given between movement (1:1) and between sets (1 minute).

Dynamic Core Group (DCG): In addition to football training, 6 different dynamic core exercises were applied 3 days per week for 10 weeks (Table 2).

Static Core Group (SCG): In addition to football training, 6 different static core exercises (Table 3) were applied 3 days per week for 10 weeks.

Control Group (CG): Athletes were subjected to an annual football training program of aerobic and anaerobic exercises, 3 days per week for 10 weeks without an additional strength training program.

Table 2: Dynamic core group training program

Exercises	Weeks 1-4 Set/Time	Weeks 5-8 Set/Time	Weeks 9-10 Set/Time
Plank + Push up	2 x 25 sec	3 x 30 sec	3 x 40 sec
Lying Twist Trunk	2 x 25 sec	3 x 30 sec	3 x 35 sec
Deep Squat	2 x 30 sec	3 x 35 sec	3 x 40 sec
Mountain Climber	2 x 20 sec	3 x 25 sec	3 x 30 sec
Crunch	2 x 35 sec	3 x 40 sec	3 x 45 sec
Burpee	2 x 30 sec	3 x 35 sec	3 x 40 sec

Table 3: Static core group training program

Exercises	Weeks 1-4 Set/Time	Weeks 5-8 Set/Time	Weeks 9-10 Set/Time
Front Plank	2 x 30 sec	3 x 35 sec	3 x 40 sec
Side Plank (Right)	2 x 25 sec	3 x 30 sec	3 x 35 sec
Side Plank (Left)	2 x 25 sec	3 x 30 sec	3 x 35 sec
Reverse Plank	2 x 20 sec	3 x 25 sec	3 x 30 sec
Crunch (Static)	2 x 35 sec	3 x 40 sec	3 x 45 sec
Leg Raise (Static)	2 x 40 sec	3 x 45 sec	3 x 50 sec

Data Collection

Measurements were taken as a pre-test before the core training program and as a post-test at the end of 10 weeks, and data were recorded. Height and body weight measurements were taken by experts in the field in a laboratory environment; all other tests were taken on a synthetic football field.

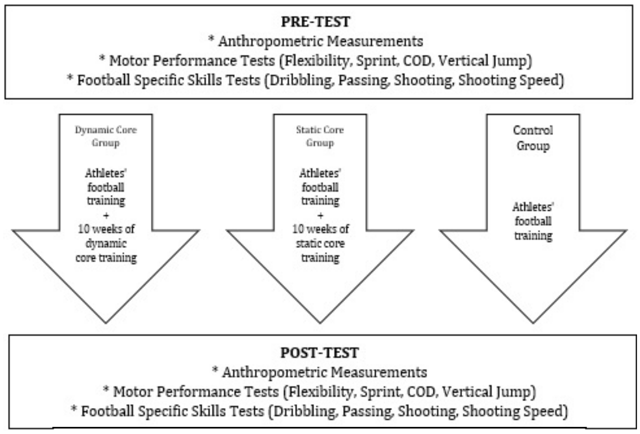

Figure 1. Data Collection

Data Collection Tools

Body Weight and Height: Body weights of the participants were measured with standard sportswear (shorts and t-shirt) and bare feet on a Tanita TBF 401 A Japan brand scale with an accuracy of 0.1 kg. The height of the participants was measured with a wall-mounted stadiometer (Holtain Ltd. U.K.) with an accuracy of 1 mm in anatomical position, barefoot, and head frontal plane (Güler, 2018).

Flexibility Test: A sit and reach test was performed to evaluate flexibility. The measurement was performed twice and the best result was recorded (Güler, 2018).

30-Meter Sprint Test: The start and finish lines in the field were made by placing 0.01 precision photocell at the start and finish points of the test (Newtest Powertimer) in predetermined 30-meter areas, taking the best of 2 trials with rest intervals.

Illinois Agility Test: A test track consisting of 3 cones arranged on a straight line at 3m intervals in width, 10m in length, and 3.3m in the middle section was established. The test consists of a slalom run with 180 degree turns every 10m, with a 40m straight track and a 20m track with cones. A two-door photocell electronic chronometer system (Newtest Powertimer) measuring with an accuracy of 0.01 seconds was placed at the start and finish after preparing the test track. Volunteers exited the start line of the test track lying on their back and their hands in contact with the ground at shoulder level. The time to finish the course was recorded in seconds. The test was repeated 2 times and the best result was recorded (Hazır, Mahir ve Açıkada, 2010).

Vertical Jump Test: The athlete was asked to stand in front of the measuring board with the body upright and the feet together, and to extend the fingertips to the maximum point, with both arms extended and the soles of the feet touching the ground. In this condition, the last point reached was marked on the board, then he was asked to turn 90º sideways to the board and come to the previously marked point at a distance of 20 cm.

The athlete was asked to first squat and then make a maximum jump upwards and touch his hand on the side of the board, the distance between the marked point before the jump and the next point was determined and recorded in cm by the researcher. Three attempts were made and the best result was recorded as a score (Dedecan, 2016).

Mor–Christian General Soccer Ability Skill Test: It is a 3-battery test that measures the level of football skill developed by Mor-Christian in 1979. The test aims to evaluate dribbling, passing, and shooting in football (Mor & Christian, 1979).

Dribbling Test: In the test, 12 cones were arranged in a circle with a radius of 18 m with a distance of 4.5 m between each cone. The start line was marked 1 m away from the circle perpendicularly. With a start command, the players dribbled the ball between the cones as quickly as possible. The test was performed twice, clockwise and counterclockwise. The best score was used for the statistical analyses.

Passing Test: For the passes test, a 91 cm wide and 45 cm high (with 91 cm distance between the two funnels) rope of 1.20 m length was placed behind the goal as a goal line. Two funnels were placed at an angle of 45 degrees to the goal line at a distance of 13.5 m, and a third funnel was placed at a distance of 13.5 m at an angle of 90 degrees to the goal line. Passing was made to the goal in the form of 4 hits from the three funnels (12 passes in total). The player used the desired foot when passing, and 1 point was given for each successful pass. Balls hit into the goal funnels were recorded as successful, and the final score was record from the sum of the 12 passes.

Shotting Test: For the shot test, 4 circles with a diameter of 1.21 m were placed inside the goal. The goal line is marked 14.5 m from the goal and parallel to the goal. The football player could hit the ball with the foot he wanted and the shots were from behind the shot line. Each of the 4 ring targets was hit 4 times, for a total of 16 times. In shooting, shots that go into the right target are scored 10 points, shots that go into the wrong target are scored 4 points. Balls entering the target directly are scored as successful, while balls entering the target by rolling or hitting the ground are scored as unsuccessful. The result was recorded as the sum of 16 attempts.

Shooting Speed: A Bushnell, USA, brand radar gun unit was used to determine shot velocity. The players were given a total of 6 shots, 3 times each with the right and left foot, from a distance of 6 m from the goal. The measurements were made on an indoor football field (artificial turf) so that the shot velocities were not affected by external factors. All shots were performed using the inside of the foot technique. Each football player performed the next shot when they felt most comfortable between shots. The average speed of 3 hits was included in the statistical analysis.

Statistical Analysis

The data of the participants were analyzed using IBM SPSS 23 package software. The test distributions of the variables pre and post training were examined according to the groups and the normality of the distributions and the homogeneity of the variances were determined by Shapiro-Wilks and Levene test. Intra-group pre-test and post-test comparisons regarding the training effect were examined with the Paired-Sample T-test and inter-group analyzes were examined with ANOVA. Post Hoc comparisons were continued with Bonferroni Test. The significant level was accepted as p<0.05.

Ethical Statement

This research was approved by the Kütahya Dumlupınar University, Social and Human Sciences Scientific Research and Publication Ethics Committee with date 25.12.2019 and number 2019/01.

Findings

According to the Table 4, no statistically significant difference was found between the dynamic core group, static core group, and control group in terms of the values obtained from the measurements made before the dynamic and static core training period for all variables (p>0.05).

Table 4: Comparison of pre-training football specific skills and motor performance of the groups

Tests	Group	Mean ± SD	F	p
Flexibility (cm)	DCG	16.65 ± 2.74	3.02	.056
	SCG	13.75 ± 3.34		
	CG	14.25 ± 5.39		
30 m (sec)	DCG	5.27 ± .39	.01	.994
	SCG	5.26 ± .43		
	CG	5.25 ± .23		
COD (sec)	DCG	17.91 ± .80	1.03	.364
	SCG	18.28 ± 1.12		
	CG	18.24 ± .75		
Vertical Jump (cm)	DCG	29.65 ± 6.03	2.35	.105
	SCG	26.90 ± 4.62		
	CG	26.70 ± 3.42		
Right Shooting Speed (km.s^{-1})	DCG	63.96 ± 9.60	2.57	.085
	SCG	58.21 ± 7.35		
	CG	59.91 ± 7.55		
Left Shooting Speed (km.s^{-1})	DCG	54.67 ± 9.55	2.87	.065
	SCG	49.41 ± 5.64		
	CG	48.92 ± 9.46		
Dribbling (sec)	DCG	18.11 ± . 51	2.12	.130
	SCG	18.79 ± 1.66		
	CG	18.88 ± 1.41		
Passing Accuracy (score)	DCG	3.40 ± 1.60	.20	.822
	SCG	3.20 ± 1.36		
	CG	3.05 ± 2.23		
Shooting Accuracy (score)	DCG	31.00 ± 12.94	.94	.397
	SCG	32.60 ± 15.63		
	CG	26.30 ± 16.52		

DCG: Dynamic core group, SCG: static core group, CG: control group

Table 5: Pre-Training and 10th week comparison of football specific skills and motor performance

Measurements	Group	Pre-test Mean ± SD	Post-test Mean ± SD	t	p
Flexibility (cm)	DCG	16.65 ± 2.7	22.95 ± 4.1	-5,41	.00*
	SCG	13.75 ± 3.3	17.80 ± 4.9	-3,04	.00*
	CG	14.20 ± 5.4	15.20 ± 6.0	-1,09	.28
30 m (sec)	DCG	5.27 ± . 39	4.98 ± . 21	4,33	.00*
	SCG	5.26 ± . 43	5.07 ± . 36	3,08	.00*
	CG	5.25 ± . 23	5.52 ± . 23	-5,51	.00*
COD (sec)	DCG	17.91 ± . 8	17.06 ± . 40	4,52	.00*
	SCG	18.28 ± 1.1	17.83 ± 1.0	1,22	.23
	CG	18.24 ± . 75	18.34 ± . 93	-.43	.66
Vertical Jump (cm)	DCG	29.65 ± 6.0	37.55 ± 3.2	-5,74	.00*
	SCG	26.90 ± 4.6	35.55 ± 4.1	-5.19	.00*
	CG	26.70 ± 3.4	31.10 ± 3.0	-4,88	.00*
Right Shooting Speed ($km.s^{-1}$)	DCG	63.96 ± 9.6	73.78 ± 4.7	-3,97	.00*
	SCG	58.21 ± 7.3	65.30 ± 6.6	-3,62	.00*
	CG	59.91 ± 7.5	63.02 ± 8.3	-2,53	.02*
Left Shooting Speed ($km.s^{-1}$)	DCG	54.67 ± 9.5	60.54 ± 5.9	-2,30	.03*
	SCG	49.41 ± 5.6	56.65 ± 3.7	-4,20	.00*
	CG	48.92 ± 9.4	53.55 ± 8.4	-2,48	.02*
Dribbling (sec)	DCG	18.11 ± . 51	15.88 ± . 97	9,16	.00*
	SCG	18.79 ± 1.6	17.93 ± 1.2	1,86	.07
	CG	19.22 ± 1.4	18.82 ± 1.7	.146	.88
Passing Accuracy (score)	DCG	3.40 ± 1.6	6.05 ± 1.3	-8,54	.00*
	SCG	3.20 ± 1.3	5.35 ± 1.6	-4,13	.00*
	CG	3.05 ± 2.2	4.05 ± 1.8	-1,78	.09
Shooting Accuracy (score)	DCG	31.00 ± 12.9	60.00 ± 16.5	-6,96	.00*
	SCG	32.60 ± 15.6	47.10 ± 19.6	-2,90	.00*
	CG	26.30 ± 16.5	38.30 ± 13.4	-2,17	.04*

DCG: Dynamic core group, SCG: static core group, CG: control group

A statistical analysis of the temporal change of the motor performance and football-specific skill measures of the groups is presented in Table 5. It was found as a result of the analysis that the differences between the weekly measurements in flexibility, 30m sprint, vertical jump, right and left foot shooting speed, passing, and shooting accuracy parameters were statistically significant in all parameters of the dynamic core group ($p<0.05$).

There is no statistically significant difference was found in other parameters ($p>0.05$). The differences between pre-test and post-test in 30m and vertical jump parameters were found to be statistically significant in the control group ($p<0.05$). However, it was observed that the significant difference in 30m speed parameters was due to this measurement because the pre-test scores were better compared to other test scores.

A statistical analysis of the post-test differences of the motor and football-specific skill measures between the groups is presented in Table 6. Statistically significant differences were found in all parameters ($p<0.05$), and all other significant differences except 30m speed, vertical jump, and passing accuracy parameters were found to originate only from the dynamic core group at the end of the 10th week.

Table 6: Intergroup 10th week comparison of the test values of football-specific skills and motor performance obtained

Measurements	DCG (1) Mean±SD	SCG (2) Mean±SD	CG (3) Mean±SD	F	p
Flexibility (cm)	22.95 ± 4.16	17.80 ± 4.92	15.20 ± 6.0	11.94	.000* (1-2, 1-3)
30m (sec)	4.98 ± .21	5.07 ± .36	5.52 ± .23	22.59	.000* (1-3, 2-3)
COD (sec)	17.06 ± .40	17.83 ± 1.04	18.34 ± .93	11.86	.000* (1-2, 1-3)
Vertical Jump (cm)	37.55 ± 3.22	35.55 ± 4.19	31.10 ± 3.01	17.71	.000* (1-3, 2-3)
Right Shooting Speed ($km.s^{-1}$)	73.78 ± 4.71	65.30 ± 6.68	63.02 ± 8.33	14.18	.000* (1-2, 1-3)
Left Shooting Speed ($km.s^{-1}$)	60.54 ± 5.99	56.65 ± 3.78	53.55 ± 8.47	6.05	.004* (1-3)
Dribbling (sec)	15.88 ± .97	17.93 ± 1.21	18.82 ± 1.79	24.35	.000* (1-2, 1-3)
Passing Accuracy (score)	6.05 ± 1.36	5.35 ± 1.60	4.05 ± 1.88	7.81	.001* (1-3, 2-3)
Shooting Accuracy (score)	60.00 ± 16.54	47.10 ± 19.67	38.30 ± 13.48	8.49	.001* (1-3)

DCG: Dynamic core group, SCG: static core group, CG: control group

Discussion

Considering the effects of 10-week dynamic and static core training in the 10-12-year-old football players who participated in the study, significant differences were found at the end of the 10 weeks in all parameters of the dynamic core group; expressed in a positive change in the parameters of flexibility, speed, vertical jump, shooting speed, passing and shooting of the static core group and in the values of vertical jump, shooting speed and shooting of the control group. When looking at the difference between the dynamic core group, static core group, and control group, it was found that there were statistically significant differences between flexibility, speed, agility, vertical jump, shooting speed, dribbling, passing, and shooting performances. It was found that all other significant differences, except for 30m sprint, vertical jump and passing accuracy were due to the dynamic core group only, and dynamic core exercises were found to have more positive effects. Recently, many studies have been conducted to determine whether core muscles development is effective in "performance enhancement" in athletes of various sports and ages. These studies have produced different results. Some have found that core muscle training improves some or all of the performance parameters in the study, such as vertical jump, standing long jump, sprint, agility, back and leg strength, right and left hand grip strength, balance, flexibility, plank, sit-up and medicine ball throw (Afyon, 2014a; Afyon, 2014b; Afyon, 2019; Afyon & Boyacı 2013; Afyon & Boyacı, 2016; Afyon, Mülazımoğlu & Boyacı, 2017; Ahmadi, Hidari, Mahdavi & Daneshmandi, 2014; Atıcı & Afyon, 2016; Balaji & Murugavel, 2013; Bashir, et al., 2018; Bayrakdar, Kılınç Boz & Işıldar, 2020; Bıyıklı, 2018; Bilici & Selçuk, 2018; Boyacı & Afyon, 2017; Boyacı & Bıyıklı, 2018; Boyacı, et al., 2018; Dilber, et al., 2016; Doğan, et al., 2016; Genç, Ciğerci & Sever, 2019; Göktepe, Göktepe, Güder & Günay, 2019; Granacher, et al., 2014; Hoshikava, et al., 2013; Imai, et al., 2014; Kabadayı, et al., 2022; Kim, 2010; Li, 2014; Mendeş, 2016; Noyes, et al., 2011; Patil, Salian & Yardi, 2012; Prieske, et al., 2015; Rahmat, et al., 2014; Reed, et al., 2012; Schilling, et al., 2013; Sekendiz, Çuğ & Korkusuz, 2010; Sever, 2017; Sharma, Geovinson & Singh Sandhu, 2012; Weston, et al., 2015; Zhao, Ge & Chen, 2013). Some found that core stability correlated to strength or endurance performance tests at different levels (Kamiş, Pekel & Aydos, 2018; Mehda, et al., 2019; Okada, Huxel & Nesser, 2011; Özmen, 2016; Van Pletzen & Venter, 2012), and some found that core muscle training has no effect on performance or core stability were not related to the strength or endurance performance tests (Parkhouse & Ball, 2011; Sharrock, et al., 2011; Söğüt, 2016). The reason for this result in the studies that argue that core training has no effect on performance is that the exercises are not applied alone but in a different protocol such as a warm-up program, the number of subjects is small, the physiology of the exercise applied and the protocol of the tests used in the measurement, as well as the application of core training in the selected sample group. This is thought to be due to the fact that the subjects may have already used such exercises in their training routine and reached a certain level.

On the other hand, when the studies conducted with child athletes in the relevant literature were examined, it was determined that the motor development of athletes improved positively as a result of core training (Bashir, et al., 2018; Bayrakdar, et al., 2020; Bıyıklı, 2018; Boyacı & Afyon, 2017; Boyacı & Bıyıklı, 2018; Boyacı & Tutar, 2018; Boyacı, et al., 2018; Hoshikava, et al., 2013; Kabadayı, et al., 2022; Rahmat, et al., 2014; Turna, 2020). In one of these studies, the researchers found that regular core training would contribute positively to basic motor development in school-aged children and that strength training with the child's own body weight would contribute to strength development in pre-adolescence and adolescence. Therefore, children should be given additional time for play/exercise (Boyacı & Bıyıklı, 2018). Bıyıklı (2018) determined that there were statistically significant increases in the sprint, vertical jump, right and left hand grip strength, and flexibility of the athletes as a result of core training applied for 10 weeks in 11-13-year-old female swimmers. In a study measuring the effects of 6 weeks of core training on selected biomotor skills in 9-10-year-old football players, researchers found that athletes improved their balance, hand grip strength, shuttle and sprint performance (Turna, 2020). Rahmat et al. (2014) found that core stabilization programme improved children's standing long jump performance in a study conducted with 19 children aged 9-12 years. Hoshikava, et al. (2013) reported that athletes' jumping and sprinting performance improved after core stabilisation training, which they applied to 12-13-year-old football players in addition to football training. In another study, Boyacı & Afyon (2017) applied core training to 20 male football players with an average age of 13.17±0.86 years for 12 weeks and found that significant improvements were achieved in 20 m sprint, standing long jump and vertical jump.

Boyacı, et al. (2018), (2018) applied dynamic and static core exercises separately as dynamic and static core exercises 3 days a week for 10 weeks to 12-14 years old male football players for 10 weeks. As a result of the training, it was determined that dynamic and static core groups obtained better results in standing long jump, vertical jump, flexibility, left hand grip strength tests compared to the control group. They showed that dynamic core group athletes obtained better test results than static core group athletes in all tests except hand grip strength tests. Bashir et al (2018) found that dynamic balance and agility performances of athletes improved at the end of core training sessions applied for 5 weeks in young tennis players. On the other hand, Bayrakdar et al. (2020) found that both exercises increased athletic performance (sprint, long jump, vertical jump and agility) at the end of 9-week static and dynamic core training in football players aged 12-14 years. Boyacı & Tutar (2018) found that children's core strength and endurance improved with Quad-Core exercises, which included 4 different plank movement positions were applied statically. Reed et al. (2012) reported that core training can provide marginal benefits for targeted athletic performance.

Although all groups in the study improved their football-specific skill test scores, it was observed that the static and especially the dynamic core group performed better than the control group as a result of core training. Static exercises have a recognized characteristic called "fixed joint angle" (Sever, 2016). Static exercises develop the strength of the angle to which they are applied (Foland, Hawker, Leach, Little & Jones, 2005; Kitai & Sale, 1989; Weir, Housh, Weir & Johnson, 1995). This development is thought to be related to the strengthening of muscle fibrils activated at that angle and the inhibition of antagonist muscles (Sever, 2016). In the systematic review study in the literature, he said that many studies were insufficient to reveal the relationship between isometric strength and performance (Juneja, Verma & Khanna, 2010). Single-angle applications seen in the majority of isometric studies do not improve dynamic performance (Fleck & Schutt, 1983; Requena, et. al., 2009). It is difficult to improve performance in this type of exercise because it does not increase joint angular velocity (Sever, 2016).

In the limited number of studies in the literature examining the effects of core training on technical skills, hitting and throwing speeds, and the level of relationship between core strength and core stabilisation and these parameters, similar results to our study were obtained (Kim, 2010; Manchado, et al., 2017; Prieske, et al., 2015; Saeterbakken, Van Den Tillaar & Seiler, 2011; Sever, Kır & Yaman, 2017; Yapıcı, 2019; Yüksel, et al., 2016). Sever, et al. (2017) found that periodic core training program increased the service speed of 12 athletes in the experimental group from 120.93 km/h to 128.6 km/h (6.6%) in 11-13 years old male tennis players.

In another study, Yapıcı (2019) found that 6-week core exercises significantly increased the service hit rate and service speed of female volleyball players. Kim (2010) found that driver shooting performance (ball speed, club head speed, and carry distance) of 9 professional female golf athletes significantly increased after 12 weeks of core strength training. Prieske et al. (2015) applied core training on stable (n=20) and unstable (n=19) surfaces in addition to football training to a total of 39 elite youth football players and reported a significant difference between the pre-test and post-test scores of shooting performance.

Saeterbakken, et al. (2011) applied core stabilization training based on sling training (6 closed kinetic chain movements on unstable ground) to 14 woman handball players for 2 days per week for 6 weeks in addition to handball training. They found that the maximum throwing speed of woman athletes increased by 4,9% compared to woman athletes in the control group. As a result, they reported that a stronger and more stable lumbar-pelvic-hip complex would contribute to high rotational velocity during multisegmental movements.

Yüksel et al. (2016), investigated the effects of core training on balance and shotting performance in male basketball players, and found that the experimental group increased the percentage of 2 and 3-point shooting in one minute. The time interaction between group and values was found to be significant. In another study, it was found that the shooting speed of 15 handball players who performed 7 lumbar-pelvic exercises for 10 weeks increased by 4.5% (Manchado, et al., 2017). The results of the studies show that core training has a positive effect on performance such as ball striking speed and ball throwing. Similar to the results in the literature, in our study, core training types, especially dynamic core training, were found to improve children's football-specific technical skills. The majority of movements for motor performance are multi-joint and involve the participation of many muscle groups (Sever, 2016).

From this point of view, these results in the literature seem to be the result of the functional work of the core muscles and their synergistic role in movements and force transfer rather than working in isolation (Akuthota & Nadler, 2004, Fredericson & Moore, 2005). Also, as mentioned above, the constant joint angle theory can explain why the development of the static core group is not as good as that of the dynamic core group.

An effective core muscle is effective in stabilizing the kinetic chain during functional exercise, transferring force between lower and upper extremities, and performing technical skills using less energy. Considering this situation, as seen in the results of the study, it is thought that core training for child footballers who have weak local and global core muscle strength and are in the developmental period will be beneficial in terms of strengthening core muscles and increasing their endurance and especially supporting their technical and motor skill development. It is thought that such an achievement is important for athletes in the lower age groups to be able to perform at a high level in a sport such as football, which lasts for a long time, involves many challenges and various movements, and to be ready for this tempo in the future.

Oliver et al., (2010) reported that core exercises applied to child athletes are beneficial for children and they enjoyed them more compared to typical sitting exercises.

Conclusion

In conclusion, in this study in which the effect of core training applied to child football players for 10 weeks was investigated, it was observed that although static core exercises had positive effects on motor performance and technical skills, dynamic core exercises were more effective for development.

In this direction, it is thought that especially dynamic core exercises should be preferred in exercise selections in trainings. In this context, since core exercises should be applied as a part of the general training session, it is thought that modified training exercises targeting the core area within the general training will have a significant positive effect on the development of football players.

Author Note

This study was produced from the doctoral thesis prepared by the first author under the supervision of the second author.

Financial Support

No financial support was received from institutions and/or institutions during the preparation and writing of this study.

Conflict of Interest

There is no conflict of interest between the authors regarding the publication of this article.

Author Contributions

Research Idea: GB, AÜ; Research Design: GB, AÜ, MBK; Analysis of Data: GB; Writing: GB; Critical Review: GB, AÜ, MBK

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