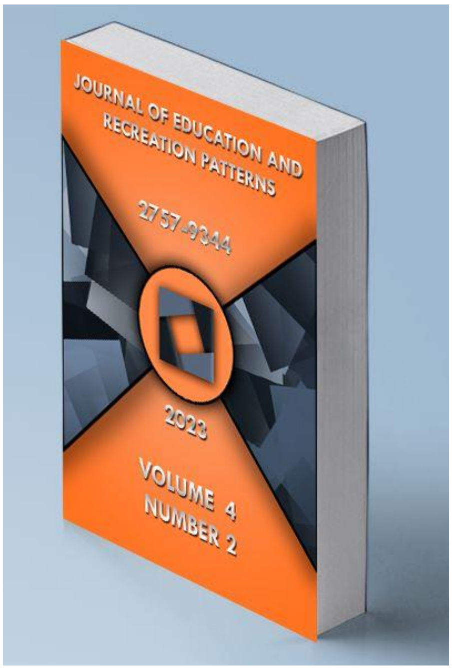

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The Effect of Core Exercise Program on Vertical Jump, Speed, Agility and Strength Parameters in Junior Male Soccer Players

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ABSTRACT

This study was conducted to investigate the effect of core exercise program on vertical jump, speed, agility and strength parameters in junior male soccer players. In the study, pretest-posttest control group design, one of the experimental models of quantitative research method, was used. The experimental group of the study consisted of 12 male soccer players ($\bar{X}$year: 12,16±,83) who underwent core exercise 3 days a week for six weeks in addition to regular soccer training, while the control group of the study consisted of 12 male athletes ($\bar{X}$year: 12,25±,62) who underwent only regular soccer training. Leg strength, core strength, vertical jump, 30 m sprint and agility tests were administered to the athletes who voluntarily participated in the study before and after six weeks of training. The normality level of the data was determined by Shapiro-Wilk test. Independent Sample T Test for independent groups and Paired Sample T Test for dependent groups were used to analyze the normally distributed data. According to the findings of the study, there was a statistically significant difference between the pre-test - post-test measurement values of all performance tests of the experimental group and core strength, vertical jump, 30 m sprint and agility tests of the experimental and control groups ($p<0.05$), while no significant difference was found in the control group ($p>0.05$). According to the results of the study, it can be said that the core exercise program applied to male football players has positive effects on the development of vertical jump, speed, agility and strength parameters.

Keywords: Core exercise, Football, Jumping, Speed, Strength

INTRODUCTION

The main purpose and focus of the research in the field of movement and training science is sportive performance. The primary aim is to identify all physical, physiological, cognitive and psychological elements that affect sportive performance positively or negatively and to try to keep the athlete's performance at the same level by increasing it to the optimum possible point (Gür, 2015). Sportive performance is the degree of formation of a certain sport motoric level. It includes specific factors due to its complex structure. There is a necessity to be versatile in the training for performance development. Maximum success is achieved with the harmonious development of the factors that determine performance (Günay & Yüce, 2008). Football is undoubtedly the most widespread and popular sport branch among the sports branches in the world. It has a unique place among other branches with its features such as the number of players, the size of the playing field and the ability to struggle (Marancı, 2001). According to the researches, it is not possible for athletes to reach the expected level of sportive performance if they do not have physical characteristics suitable for their branches. In addition, just having physical characteristics suitable for their branches does not mean that they will perform at the highest level (Özkan et al., 2005). There are many factors affecting performance and one of them is physical structure, that is, physical characteristics. The reason for this is that physical structure or physical characteristics directly affect the demonstration of physiological capacities. The branch-specific compatibility of physical structure and high physiological capacity are among the important criteria in terms of performance (Gürses and Olgun, 1996). Therefore, the lack of a certain level of physical structure, physiological capacity and biomotor components that make up the performance (Sevim, 1995) in athletes will prevent the expected values from being reached. Physical structure, which is one of the factors affecting the high performance expected from the athlete, positively affects the performance of the athlete by combining with other performance elements such as strength, power, flexibility, speed, endurance and quickness (Açıkada & Ergen, 1990). One of the features that increase this positive effect is the stabilisation of the core. Core stabilisation is generally defined as ensuring the postural continuity of the muscles around the lumbo pelvic region, which is the centre of the body in dynamic and static positions (static stability) or determining the trajectory of the movement to be revealed (dynamic stability). Core stabilisation also shows the role of the trunk muscles in maintaining balance and stabilisation of the spinal cord and even the whole body (Chabut, 2009). The functional importance of core stabilisation and force production is becoming increasingly evident in many sports. From throwing to running; trunk stabilisation plays a pivot role in an effective biomechanical function for power generation and reducing the load on the joints (Kibler, Press, & Sciascia, 2006). This region, defined as the central region of the body, is the point where the stabilisation of the abdominal, paraspinal and gluteal muscles, consisting of muscles, nerves, skeletal and other connective tissues that form the spine, pelvis, abdominal cavity and superstructures, is critical for optimal performance (Başandaç, 2014; Nadler, et al., 2002). The tasks of these muscles are to support posture, to enable movement, to control muscle activities, to provide stability, to absorb power, to generate power, to transfer power between extremities and joints (Handzel, 2003). It can be said that core stabilisation refers to the appropriate neuromuscular structure for force transfer and control of the upper and lower extremities within the entire kinetic chain for dynamic mobility and power generation (Takatani, 2012). The kinetic chain expressed here was defined by Steindler as "a combination of different well-organised joints that form the basis of a complex movement unit" (Steindler, 1955). Borghuis et al. (2008) state that motion at one segment will influence that of all other segments in the chain. A strong kinetic chain will increase the efficiency in the execution of movements or transitions between movements due to the increase in the strength of many muscles in the core region, prevention of injury risk and improvement in balance ability (Herrington & Davies, 2005). As a matter of fact, scientific studies have shown that core exercises provide improvements in performance parameters (Cosio-Lima et al., 2003; Carpes et al., 2008). At this point, training without paying attention to the core area increases the risk of injury in the participants and may limit their technical skills, so a strong core area allows the athlete to load more, as well as making technical movements more efficient and flexible (Şatıroğlu, Aslan, & Atak, 2013). Altundağ et al. (2021) examined the effect of 8-week core and corrective exercises applied to female volleyball players on functional movement screening test scores. As a result of their study, they recommended that core and corrective exercises should be added to training programmes to reduce the risk of injury and improve functional movement patterns of athletes in volleyball.

Today's sports require participants to have an ideal level of physical fitness, which is a process that requires more loading. It is very important to develop core strength in order to improve the propulsive force produced by the legs and to get better performance with high performance output (Stanton et al., 2004; Şatıroğlu, Aslan, & Atak, 2013). It is known that core weakness may affect athletic performance as well as neurological injuries with vertebral problems. Therefore, it is thought that measures should be taken to eliminate these problems while making training plans. This multicomponent structure of the sportive performance phenomenon points to a multifaceted training programme that a footballer should apply in order to be successful. Core muscles and training for these muscles are an important part of this component. Based on the idea that the core exercise programme will increase the contraction endurance of the core region muscles one after the other, the body stabilisation will create resistance to fatigue in different positions and for a longer time, which will reduce the functional losses that may arise from the lack of stability in the athlete, and at the same time prevent the risk of injury and positively affect the athletic performances of the athletes, this study aimed to investigate the effects of core exercise activities on some motoric characteristics of male football players such as vertical jump, speed, agility and strength.

METHOD

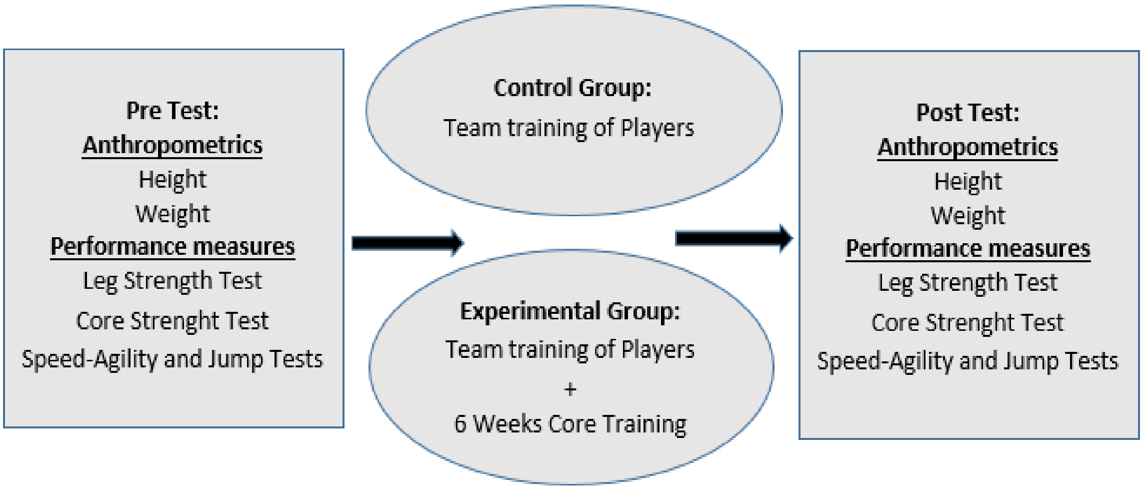
Participants

In the study, pretest-posttest control group design, one of the experimental models, was used. Twenty-four male soccer players, aged between 11-13 years and regularly practicing soccer, voluntarily participated in the study. These athletes were randomly divided into two groups, one experimental group (n = 12, mean age, 12.16±.83 years; mean height, 166.58±7.44 cm; mean body weight, 51.4±9.25 kg) and one control group (n = 12, mean age, 12.25±.62 years; mean height, 165.66±6.05 cm; mean body weight, 49.90±6.03 kg). The inclusion criteria were (a) playing soccer for at least 1 year; (b) not having any history of injury that would affect the outcome of the study; (c) participating regularly in the study; and (d) following the instructions of the researchers throughout the study. G*power (3.1.9.4) power analysis program was used to determine the number of participants to be included in the study. As a result of the power analysis (confidence interval=.95, alpha value=.05 and beta value=.80), it was determined that a total of 20 volunteers should be included in the research and the number of volunteers was determined as 24 (Experiment: 12 Control: 12) to increase the reliability of the research. In the research conducted in accordance with the Declaration of Helsinki, the participants who volunteered to participate in the research were interviewed and informed about the content of the research and the "Informed Voluntary Consent Form" was signed by the volunteers. Ethical approval was obtained from Muş Alparslan University Scientific Research and Publication Ethics Committee for the conduct of the research (Approval Number: 10.07.2023-99022).

Experimental Design of the Study

Pretests were applied to the athletes in the experimental and control groups before starting the study. While the athletes in the experimental group were applied a core strength training programme prepared by using the research of Willardson (2014), which included basic core exercises performed with their own body weight for 6 weeks in addition to football training three (3) days a week, the football players in the control group were not included in the core exercise programme and continued their routine football training programme for 6 weeks. After the end of the six-week training programme, post-tests were applied to both groups and the data collection phase was completed (Figure 1).

Figure 1. *Experimental Design Diagram*



Core Exercise Program

The scope of the exercise was applied as movement time. In the core exercise programme consisting of 10 exercises (Prone Plank, Side bridge, Scissor Flutter Kick, Sit Up, Jackknife, Superman, Leg Lower, Bird Dog, Bicycle Crunch, Swimmer) and prepared by using Willardson's (2014) research, the duration of each core movement is 30 s, resting time is 45 s and repetition is 2 for 1- 3 weeks. As the adaptation of the athletes was achieved, variables such as loading and scope were gradually increased in the context of the principle of increasing loading for subsequent adaptations (Bompa, 2009), and the application time of the movements was applied as 45 seconds, rest time as 60 seconds and repetition as 2 from the 4th week (Table 1).

Table 1. Core Exercise Program of 6 Weeks

Exercises	1.-3nd Week	4.-6th Week
	Time / Rest / Reps	Time / Rest / Reps
Prone Plank	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Side bridge	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Scissor Flutter Kick	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Sit Up	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Jackknife	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Superman	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Leg Lower	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Bird Dog	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Bicycle Crunch	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec
Swimmer	30 sec x 2 reps x 45 sec	45 sec x 2 reps x 60 sec

Data Collection Tools

Height Measurement: Participants' height was measured with a stadiometer (SECA, Germany) with an accuracy of 0.01 meter (m). Height was measured with the head in the frankfort plane, following a deep inspiration, the distance between the vertex of the head and the foot was measured in a standing position without shoes, heels together, knees straight and tense, body and head upright and facing each other, the sliding caliper of the stadiometer was stopped when it touched the head of the volunteers, and the closest value was recorded as the height value in centimeters (cm).

Body Weight Measurement: The body weights of the participants were measured with an electronic scale (Tanita BC- 418 MA, Japan) with an accuracy of 0.1 kilogram (kg), the volunteers were wearing shorts or swimsuits that would not affect their weight, and the results were recorded in kilograms (kg).

Leg Strength Test: Leg strength was measured with Takei brand leg dynamometer adjusted according to the participant. After placing his/her feet on the dynamometer stand with knees bent, the participant pulled up the dynamometer bar vertically using his/her legs to the maximum extent with his/her arms stretched, back straight and trunk slightly tilted forward. This traction was repeated 2 times, and the best value was recorded for each athlete (Biçer and Akkuş, 2010).

Core Strength Test: Core strength of the participants was measured with the "Sport-Specific Core Muscle Strength & Stability Plank Test" protocol developed by Mackenzie (2005). The protocol consists of 8 steps with a total duration of 3 minutes. After the first step was started, if the athlete failed to stay in the appropriate plank position (hand, foot touching the ground, disruption of the initial shape of the trunk, etc.) at which second of each step, that time was recorded as the athlete's test score. When the athlete successfully completed all 8 steps, he/she was considered to have successfully passed the test and the duration of the test was recorded as the athlete's score.

Vertical Jump Test: It is a test used to determine the level of leg quick strength, jumping strength and alactacid anaerobic power. Vertical jump measurements of the athletes were measured with an electronic jump mat (Smart Jump; Fusion Sport, Australia). All athletes were asked to stand on the mat with their hands on their waist and when the athletes were ready, they were asked to jump to the highest point they could jump to and the athlete fell back on the mat after jumping. The athletes were given two attempts, and their jump heights were measured in cm and their best degrees were recorded (Atan, 2019).

30-m Sprint Test: A "30 m sprint test" was performed to determine the speed performance of the participants. Running scores were recorded in seconds with electronic gate timers (Smart Speed; Fusion Sport, Australia) placed at the start and finish line. Sufficient rest time (3 minutes) was allowed between measurements to demonstrate maximal performance. The test was repeated twice for each participant for reliability and the best performance score was recorded (Hopkins, 2000).

Illinois Agility Test: The Illinois test was applied to evaluate the agility performance of the participants. The test consists of a 40 m straight run with 180º turns every 10 m and a 20 m slalom run between cones. The test track, consisting of three cones arranged on a straight line with a width of 5 m, a length of 10 m and 3.3 m intervals in the middle section, was set up on an artificial turf football field. After the test track was prepared, a two-door photocell electronic stopwatch system (Smart Speed; Fusion Sport, Australia) with an accuracy of 0.01 s was placed at the beginning and end. The test was repeated twice for each participant for the reliability of the test and the best performance value was recorded in seconds (Hopkins, 2000).

Statistical Analysis

SPSS 22.0 package program was used for statistical analysis of the data. Normality levels of the data were determined by Shapiro-Wilk test. Parametric tests were preferred in the analysis of normally distributed data. Independent Sample T Test for independent groups and Paired Sample T Test for dependent groups were used and significance level was accepted as 0.05 in statistical comparisons. Effect sizes (ES) of mean differences were determined using Cohen's d-test and effect sizes were categorized according to Hopkins scale: 0.0-0.2 = insignificant; 0.2-0.6 = small; 0.6-1.2 moderate; 1.2-2.0 = large; > 2.0 = very large (Hopkins et al., 2009).

FINDINGS

In this part of the study, the findings of the research examining the effects of core exercise programmed on vertical jump, speed, agility and strength parameters are presented.

Table 2. Independent Sample t-Test Results Regarding General Characteristics of Groups

Parameters	Group	n	x̄	Sd.	t	p
Age (year)	Experimental	12	12.16	.83	-.277	.784
	Control	12	12.25	.62		
Height (cm)	Experimental	12	166.58	7.44	1.415	.171
	Control	12	162.66	6.05		
Body Weight (kg)	Experimental	12	51.40	9.25	.481	.635
	Control	12	49.90	6.03		

cm: centimeters; kg: kilogram

According to Table 2, there was no statistically significant difference between the experimental and control groups in terms of general characteristics (p>0.05).

Table 3. Independent Sample t-Test Results Regarding the Pre-Test Values of the Groups

Parameters	Group	n	x̄	Sd.	t	p
Leg strength (kg)	Experimental	12	77.38	6.61	-.759	.456
	Control	12	79.13	4.49		
Core strength (sec)	Experimental	12	108.91	28.05	.814	.425
	Control	12	101.25	16.67		
Vertical jump (cm)	Experimental	12	30.41	3.60	.344	.734
	Control	12	29.91	3.56		
30 m Sprint (sec)	Experimental	12	4.63	.21	-2.045	.053
	Control	12	4.82	.22		
İllinois agility (sec)	Experimental	12	17.32	.49	-1.638	.116
	Control	12	17.70	.63		

sec: second; cm: centimeters; kg: kilogram

According to Table 3, there was no significant difference between the leg strength, core strength, vertical jump, 30 m sprint and Illinois agility pre-test values of the athletes in the experimental and control groups (p>0.05). The fact that there was no significant difference between the baseline values of both groups (p>0.05) shows that these groups have similar characteristics.

Table 4. Independent Sample T-Test Results for the Post-test Values of the Groups

Parameters	Group	n	x̄	Sd.	t	p	ES
Leg strength (kg)	Experimental	12	84.59	7.32	1.667	.110	
	Control	12	80.56	4.06			
Core strength (sec)	Experimental	12	129.08	22.90	2.960	**.007***	1.20
	Control	12	104.33	17.73			
Vertical jump (cm)	Experimental	12	34.05	2.85	2.164	**.042***	0.88
	Control	12	30.87	4.22			
30 m Sprint (sec)	Experimental	12	4.54	.17	-3.497	**.002***	1.47
	Control	12	4.79	.17			
İllinois agility (sec)	Experimental	12	16.08	.35	-6.780	**.000***	2.80
	Control	12	17.46	.60			

*p<0.05; sec: second; cm: centimeters; kg: kilogram; ES: Effect Size

According to Table 4, while there was no statistically significant difference between the leg strength posttest values of the athletes in the experimental and control groups (p>0.05), statistically significant differences were found between the groups in core strength, vertical jump, 30 m sprint and Illinois agility posttest values (p<0.05). It was determined that the effect size of the significant difference seen in Core strength (Cohen's d=1.20) and 30 m sprint (Cohen's d=1.47) values was at a large level (Cohen's d=1.20). The effect size of the significant difference seen in vertical jump (Cohen's d=0.88) values was found to be at medium level, and Illinois agility (Cohen's d=2.80) values were found to be at very large level.

In the core strength test, the post-test values of the athletes in the experimental group (129.08±22.90) were higher than those in the control group (104.33±17.73). In the vertical jump test, the posttest values of the athletes in the experimental group (34.05±2.85) were higher than those in the control group (30.87±4.22). In the 30 m sprint test, the posttest values of the athletes in the experimental group (4.54±.17) were lower than those in the control group (4.79±.17). In the Illinois agility test, the post-test values of the athletes in the experimental group (16.08±.35 s) were lower than those in the control group (17.46±.60).

Table 5. Paired Sample t-Test Results for Experimental Group Pre-Test and Post-Test Values

Parameters	Group	n	x̄	Sd.	t	p	ES
Leg strength (kg)	Pre test	12	77.38	6.61	-4.428	**.001***	1.03
	Post test	12	84.59	7.32			
Core strength (sec)	Pre test	12	108.91	28.05	-5.793	**.000***	0.78
	Post test	12	129.08	22.90			
Vertical jump (cm)	Pre test	12	30.41	3.60	-7.240	**.000***	1.12
	Post test	12	34.05	2.85			
30 m Sprint (sec)	Pre test	12	4.63	.21	2.381	**.036***	0.64
	Post test	12	4.51	.16			
İllinois agility (sec)	Pre test	12	17.32	.49	8.520	**.000***	2.91
	Post test	12	16.08	.35			

*p<0.05; sec: second; cm: centimeters; kg: kilogram; ES: Effect Size

When the pre-test - post-test measurement values of the participants are analyzed in Table 5, a statistically significant difference was found between the leg strength, core strength, vertical jump, 30 m sprint and Illinois agility pre-test and post-test values of the athletes in the experimental group (p<0.05). The effect size of the significant difference in leg strength (Cohen's d=1.03), core strength (Cohen's d=0.78) and vertical jump (Cohen's d=1.12) values was found to be at a moderate level. The effect size of the significant difference in 30 m sprint

(Cohen's d=0.64) was found to be at a small level, and Illinois agility (Cohen's d=2.91) was found to be at a very large level.

The leg strength test posttest values (84.59±7.32) were higher than the pre-test values (77.38±6.61), core strength posttest values (129.08±22.90) were higher than the pre-test values (108.91±28.05), vertical jump posttest values (34.05±2.85) were higher than the pre-test values (30.41±3.60). The 30 m sprint test posttest values (4.51±.16) were lower than the pre-test values (4.63±.21) and the Illinois agility test posttest values (16.08±.35) were lower than the pre-test values (17.32±.49).

Table 6. Paired Sample t-Test Results for Control Group Pre-Test and Post-Test Values

Parameters	Group	n	x̄	Sd.	t	p
Leg strength (kg)	Pre test	12	79.13	4.49	-2.007	.070
	Post test	12	80.56	4.06		
Core strength (sec)	Pre test	12	101.25	16.67	-1.512	.159
	Post test	12	104.33	17.73		
Vertical jump (cm)	Pre test	12	29.91	3.56	-1.184	.261
	Post test	12	30.87	4.22		
30 m Sprint (sec)	Pre test	12	4.82	.22	.610	.554
	Post test	12	4.79	.17		
İllinois agility (sec)	Pre test	12	17.70	.63	1.356	.202
	Post test	12	17.46	.60		

sec: second; cm: centimeters; kg: kilogram

According to the results in Table 6, there was no significant difference between the pre-test and post-test values of leg strength, core strength, vertical jump, 30 m sprint and Illinois agility values of the athletes in the control group (p>0.05).

DISCUSSION

In order for soccer players to perform well, their basic motoric characteristics must be at a high level before the basic skills of soccer. For the desired elite level soccer success, it is necessary to determine the physical and mental requirements of soccer correctly and to train soccer players with scientifically correct methods. Therefore, in order to reach the desired levels, it is necessary to develop speed, agility, strength, flexibility, power, aerobic and anaerobic limits, for which regular training is important. In this study, the effects of core exercise practices on vertical jump, agility, speed and strength parameters of junior male soccer players were investigated. For this purpose, the parameters measured in the study were determined with a two-stage study as pre-test and post-test and the results were discussed and presented in the light of the literature.

Evaluation of Leg Strength Performance

Soccer players, who are always on the move during the competition, need strength for every action they perform in the game. Soccer strength includes many elements. As a matter of fact, researchers state that strength is an important parameter for success in soccer (Gissis et al., 2003; Mjolsnes et al., 2004; Reilly & Gilbourne, 2003). In the study, when the pre-test - post-test measurement values of the experimental group were analyzed, it was determined that the leg strength values showed a statistically significant difference. When the mean values were compared, it was seen that the post-test measurement values were better. Since core exercises provide more stability for proximal to distal movements of the lower extremities, improving core function can increase leg strength (Kibler et al., 2006). When the pre-test and post-test measurement values of the control group were examined, it was determined that the leg strength values did not show a statistically significant difference. When the post-test results of the experimental and control groups were compared, it was determined that the leg strength measurement values did not show a statistically significant difference. In the study of Dello Iacono et al. (2016), in which they examined the effects of core stability training on muscle asymmetries and imbalances, a significant decrease was observed in strength asymmetries in the core exercise group, and it was stated that the exercises had positive effects on the development of optimal lower extremity power balance in young football players. In another study on the activation of core region and lower extremity muscles, it was found that core exercises improved the activity levels of core region (obliques externus abdominis and erector spinae) and lower extremity (tibialis anterior) muscles ($p \leq 0.03$) (Oshima et al. ,2019). A similar positive effect was observed in a study by Doğan et al. (2016), which showed a significant improvement in leg strength values of 44 soccer players after 8 weeks of core training. In another study, Drinkwater et al. (2007) reported an increase in leg strength after applying a core-based training programme with a bosu ball. Our study does not coincide with the data obtained from these studies in leg strength parameters. It is thought that this difference may be due to differences in age, training duration and exercise protocols.

Evaluation of Core Strength Performance

When the pre-test - post-test measurement values of the experimental group were analysed, it was determined that the core force values showed a statistically significant difference. When the mean values are compared, it is seen that the post-test measurement values are better. When the pre-test and post-test measurement values of the control group were analysed, it was determined that the core strength values did not show statistically significant difference, and when the post-test results of the experimental and control groups were compared, it was determined that the vertical jump measurement values differed. When the mean values were compared, it was determined that the core exercise group had better measurement values.

D'Isanto et al. (2019) concluded that strength training is the most important component of an athlete's performance. Another researcher suggested that core training improves force transmission, coordinated combination and muscle control ability (Yu et al., 2008). It embodies a new concept such as whole-body integrity and the participation of multiple muscle groups in sports in multiple dimensions at the same time (Yu et al., 2008). In fact, core training that integrates multiple muscle groups requires more coordination, which may improve power strength adaptation and thus on-field performance (Yu et al., 2008; Suchomel et al., 2018).

The core region consists of the abdominal muscles in the front, the back muscles in the back, the diaphragm at the top and the pelvic floor muscles at the bottom, and it is known that core strength accelerates the upper and lower extremity muscles during sportive activities and may also form the basis for force transfer between distal and proximal body parts. Therefore, core strength protects the spine and ensures the sustainability of the pelvic neutral position (Samson et al., 2007; Standaert et al., 2008). This may be important in terms of preventing sports injuries and improving body control and balance (Koz & Ersöz, 2010). Boyacı and Tutar (2018) reported that "core muscle strength and endurance improved with the Quad-Core training programme protocol" applied on child athletes. However, in a study, it was reported that core training had significant effects on abdominal muscles and rectus femoris activation (Cowley et al., 2007; Kean et al., 2006). In another study, it was found that a group performing static and dynamic exercises on a moving floor improved in core (plank, penknife and back extension) tests (Parkhouse & Ball, 2011). In another study in which the effects of core exercises on athletic performance were examined, it was stated that core exercises improved trunk muscle strength, sprint and shooting performances when applied with regular football training (Prieske et al., 2015). When the findings of the evaluation of the core strength tests of the study and control groups are compared with the literature, our research findings are in parallel with the results of many studies. In these studies (Moffroid et al., 1969; Dendas, 2010;

Saeterbakken et al., 2011; Cuğ et al., 2012; Weston et al., 2015), positive increases in core strength measurements were observed in the groups in which core exercises were applied.

Evaluation of Vertical Jump Performance

Vertical jumping, which is a physical characteristic that should be taken into consideration for high-level performance, varies in importance depending on the position in football. Explosive strength, which is associated with high level performance, is important in sports such as football (Stolen et al., 2005).

When the pre-test - post-test measurement values of the experimental group were analysed, it was determined that the vertical jump values showed a statistically significant difference. When the mean values are compared, it is seen that the post-test measurement values are better. When the pre-test and post-test measurement values of the control group were analysed, it was determined that the vertical jump values did not show a statistically significant difference. When the post-test results of the experimental and control groups were compared, it was found that the vertical jump measurement values differed. When the mean values were compared, it was determined that the core exercise group had better measurement values.

It was reported that 8-week core exercise practices combined with plyometric exercises increased jump performance and explosive power (Cabrejas et al., 2023). Dilber et al. (2016) found statistically significant differences in terms of vertical jump value because of their study applied to university football team players. Sannicandro et al. (2015) examined 42 young basketball players and found a significant difference in jump performance after 4 weeks of core training (2 times a week, 1 hour/session). Many studies have revealed that core exercises create significant differences in long jump or vertical jump values of footballers (Boyacı & Afyon, 2017). Hoshikawa et al. (2013) reached similar results with our study and stated that adding core training to athlete training in early adolescence will increase hip extensor strength and vertical jump values. Sharma et al. (2012) examined the effect of core strengthening training programme on body imbalance through vertical jump performance and static balance variables of volleyball players. They found that a nine-week core training programme had a positive effect on static balance and vertical jump values. In another study, Sztruzik et al. (2014), in a study on 20 basketball players, found that regular lower extremity core strength exercises performed by athletes contributed positively to vertical jump and shooting performance (Struzik, Pietraszewski, & Zawadzki, 2014). Civan, A., Karhan, A., & Civan, A.H. (2022) suggest that 8 weeks of regular and planned plyometric training may contribute to improvements in vertical jump, anaerobic power, and explosive strength in athletes. The findings obtained in the study are similar to the findings in the literature.

Evaluation of 30 m sprint performance

The product of the body's strength and speed reflects power (Baker & Nance, 1999). Most coaches agree that many explosive tasks such as sprinting, jumping, throwing and kicking require strength for successful performance (Young & Bilby, 1993). This is because these sports require high-speed movement and power production (Young & Bilby 1993; Young, 2006). Speed plays a critical role in football and core strength is important for athletic performance (Faude et al., 2012; Jeffreys et al., 2018); this can be explained by the theory that a stronger core enables the spine and pelvis to maintain stability (Handzel, 2003). However, it increases the stability of the centre of gravity during fast running and reduces fluctuations in this centre. By increasing the stability and flexibility of the hip joint, the athletes' range of motion, stride and stride frequency increase during the actual movement process (Meng et al., 2009).

When the pre-test - post-test measurement values of the experimental group were analyzed, it was determined that the speed values showed a statistically significant difference.

When the mean values are compared, it is seen that the post-test measurement values are better. When the pre-test and post-test measurement values of the control group were analyzed, it was determined that the speed values did not show statistically significant difference, and when the post-test results of the experimental and control groups were compared, it was determined that the speed measurement values differed. When the mean values were compared, it was determined that the measurement values of the core exercise group were better. Bora and Dağlıoğlu (2022), examined 18 young male volleyball players and found that there was a significant difference in the speed test after 6 weeks of core training (3 times a week, 1 hour/session). A similar positive effect was found in a different study after 4 weeks of core training (3 times a week) increased speed performance among 23 male students (Akbulut et al., 2020). In a study conducted by Mendes (2016) on 31 football players aged 18-30 years, it was stated that core strength training positively affected the speed parameters (10 m and 20 m sprint) of football players and may contribute to speed performance. In another core study, it was reported that core training improved 10-metre sprint ability (Sannicandro et al., 2020). Tamer et al. (2017) found statistically significant differences between 10-30 m speed, pre-test and post-test values as a result of 8-week exercise programme. In the study of Kurtay (2023), which examined the "effect of core training on physical performance", it was determined that there was no significant difference in the control group when the 30 m run analysis results were evaluated, but a significant difference was observed in the core exercise groups. In the study conducted by Gök (2021), it was determined that a significant difference occurred in dynamic and static core exercise groups. The findings obtained in the study are similar to the findings in the literature.

Evaluation of Agility Performance

Agility refers to the capacity to change body direction and position rapidly (Draper, 1985). The core can be considered the centre of the kinetic chain in sport. Developed core muscles result in improved motor recruitment, nerve recruitment and neural adaptation (Sever & Zorba, 2018). Thus, core strength, balance and movement control maximise the function of the lower and upper extremities. It should be predicted that athletes' motor skills such as coordination, agility, speed and balance in sports such as football will improve as their core strength and stability improve. Turns or changes in direction are important in agility assessments. Rotation indicates energy loss, which means decreased performance. In the core muscle groups, the external oblique, along with the hip and upper back muscles, creates and controls the rotation necessary to perform these actions (Shinkle et al., 2012). Therefore, strong lateral core muscles not only facilitate rotational movement in a number of tasks, but also resist rotational pressure in other activities (Shinkle et al., 2012). This may help footballers to improve their agility.

When the pre-test - post-test measurement values of the experimental group were analyzed, it was determined that the agility values showed a statistically significant difference. When the mean values are compared, it is seen that the post-test measurement values are better. When the pre-test post-test measurement values of the control group were examined, it was determined that the agility values did not differ statistically significantly, and when the post-test results of the experimental and control groups were compared, it was determined that the agility measurement values differed. When the mean values were compared, it was determined that the core exercise group had better measurement values. Sighamoney et al. (2018) showed that 4-week core training (5 times a week) improved agility performance among badminton players. Another study identified a significant difference in agility performance among runners after 4 weeks of core training (3 times per week) (Werasirirat et al., 2022). Akçınar and Macit (2020), suggested that 8 weeks of core training (3 times a week, 25-30 minutes) improved agility performance in male handball athletes. As a result of the agility tests performed by Yang (2014) in the groups to which he applied core exercise for 12 weeks, it was stated that there was a significant difference between pre-test and post-test values. In the study of Balaji and Murugavel (2013), in which core exercise was applied to the subjects for 8 weeks, it was determined that there was a significant difference when the pretest-posttest results of agility values were evaluated. The findings obtained in the study are similar to the findings in the literature. When the results of our study and the literature were compared, it was determined that there were similar results as well as results that were not parallel to our study (Aslan, 2014; Camcıoğlu, 2018). It is thought that this difference in the studies may be due to reasons such as the variety of subject groups included in the studies, differences in the duration and intensity of the application of the preferred methods.

Conclusion

According to the results of this study, it can be said that core exercise program has positive effects on the development of vertical jump, speed, agility and strength performance parameters. Therefore, the inclusion of core exercises similar to those in this study in training plans may allow athletes to improve their performance.

Recommendations

Future studies that will determine the effects of different types and durations of core exercises on different sports performance parameters of different sport types will provide important contributions to sports performance.

Limitations

The fact that male football players participated in this study can be considered as a limitation. Therefore, future studies should include evaluations that allow comparison of the effects of core exercises on the performances of different groups.

REFERENCES

Açıkada, C., & Ergen, E. (1990). *Science and Sport.* Büro-Tek Offset Printing. Ankara.

Akbulut T, Çinar V, Söver C, & Karaman M. (2020). Investigation of effects four week core training programme on some physical parameters. *Gaziantep University Journal of Sport Sciences,* 5:47-56. https://doi.org/10.31680/gaunjss.653699

Akçınar F., & Macit S. (2020). Investigation of the effects of core workouts on selected biomotor and branch specific techniques in 9-10 years aged male handball athletes. *Afr Educ Res J.*, 8:121-8. Available online at: https://eric.ed.gov/?id=EJ1248948

Altundağ E., Aka H., Aktuğ Z.B., Akarçeşme C., & Soylu Ç. (2021). The effect of core and corrective exercises applied to female volleyball players on functional movement screening test scores. *Gazi Journal of Physical Education and Sport Sciences*, 26(3), 333- 345 https://doi.org/10.53434/gbesbd.932956

Aslan A. K. (2014). *The Effect of Eight Weeks Core Training on Balance and Functional Performance in Young Footballers.* Master Thesis, Selçuk University Institute of Health Sciences, Konya

Atan, T. (2019). The Effect of Different Warm-up Protocols on Joint Range of Motion, Jumping and Sprint Performance. *OPUS International Journal of Society Researches*, 13(19), 621-635. https://doi.org/10.26466/opus.574260

Baker D., & Nance S. (1999). The relation between strength and power in professional rugby league players. *J Strength Condit Res.*, 13:224–9 https://doi.org/10.1519/00124278-199908000-00008

Balaji E. & Murugavel K. (2013). Motor fitness parameters response to core strength training on Handbal Players. *International Journal for Life Sciences and Educational Research,* 1(2):76-80.

Başandaç, G. (2014). *The Effect of Progressive Body Stabilisation Training on Upper Extremity Functions in Adolescent Volleyball Players*. Master Thesis, Hacettepe University, Ankara

Biçer, M., & Akkuş, H. (2010). The Effects Of Pre-Season Training On Some Physical And Physiological Parameters On Soccer Players. *Journal of Physical Education and Sport Sciences*, 7(2). 27-34

Bompa, T.O., & Haff, G.G. (2009). Periodization: *Theory and methodology of training*. Human Kinetics Publishers.

Bora H., & Dağlıoglu Ö. (2022). Effect of core strength training program on anaerobic power, speed and static balance in volleyball players. *Eur J Phys Educ Sport Sci*, 8:4355. Available online at: https://oapub.org/edu/index.php/ejep/article/view/4355. https://doi.org/10.46827/ejpe.v8i5.4355

Borghuis, J, Hof, AL, and Lemmink, K. (2008). The importance of sensory motor control in providing core stability. *Sports Med* 38: 893–916. https://doi.org/10.2165/00007256-200838110-00002

Boyacı, A. & Tutar, M. (2018). The Effecet of the Quad-Core Training on Core Muscle Strength and Endurance. *International Journal of Sports Science*. 8 (2), 50-54.

Boyacı, A., Afyon, Y. A. (2017). The effect of the core training to physical performance in children. *Journal of Education and Practice*, 8(33), 81-88.

Cabrejas, C., Solana-Tramunt, M., Morales, J., Nieto, A., Bofill, A., Carballeira, E., & Pierantozzi, E. (2023). The Effects of an Eight-Week Integrated Functional Core and Plyometric Training Program on Young Rhythmic Gymnasts' Explosive Strength. *International journal of environmental research and public health*, 20(2), 1041. https://doi.org/10.3390/ijerph20021041

Camcıoğlu N. U. (2018). *The Effect of Stabilisation Exercises on Performance in Amputee Football Players*. Master Thesis. Hasan Kalyoncu University Institute of Health Sciences Department of Physiotherapy and Rehabilitation. Gaziantep.

Carpes, F.P., Fernanda, B.R. & Carlos, B.M. (2008). Effects of A Program For Trunk Strength And Stability On Pain, Low Back And Pelvis Kinematics, And Body Balance: A Pilot Study. *Journal of Bodywork And Movement Therapies*. 12 (1), 22-30. https://doi.org/10.1016/j.jbmt.2007.05.001

Chabut, L. (2009). *Core Strength For Dummies*, Wiley Publishing, Inc. U.S.A.

Civan, A.,Karhan, A. & Civan, A.H. (2022). Investigation of the Effect of Plyometric Training on Anaerobic Capacity in Skateboard Athletes. *Journal of Education and Recreation Patterns (JERP)*, 3 (2), 48-59. https://doi.org/10.53016/jerp.v3i2.51

Cosio-Lima, L.M., Reynolds, K.L. & Winter, C. (2003). Effects of Physioball And Conventional Floor Exercises On Early Phase Adaptations İn Back And Abdominal Core Stability And Balance İn Women. *The Journal of Strength & Conditioning Research*. 17 (4), 721-5 https://doi.org/10.1519/00124278-200311000-00016

Cowley P, Swensen T, & Sforzo, G (2007): Efficacy of instability resistance training. *International Journal of Sports Medicine*, 28(10), 829-835. https://doi.org/10.1055/s-2007-964893

Cronin J., & Sleivert G. (2005). Challenges in understanding the influence of maximal power training on improving athletic performance. *Sports Med*, 35:213–34. https://doi.org/10.2165/00007256-200535030-00003

Cuğ M, Ak E, Özdemir RA, Korkusuz F., & Behm DG (2012). The effect of instability training on knee joint proprioception and core strength. *Scand J Med Sci Sports*.,11,3, 468-474.

Dello Iacono A, Padulo J, & Ayalon M. (2016). Core stability training on lower limb balance strength. *Journal of Sports Sciences*, 34:7, 671-678, https://doi.org/10.1080/02640414.2015.1068437

Dendas AM. (2010). *The relationship between core stability and athletic performance*. Doctoral Dissertation, Humboldt State University.

Dilber, A. O., Lağap, B., Akyüz, Ö., Çoban, C., Akyüz, M., Murat, T. A. Ş., ... & Özkan, A. (2016). The effect of 8-week core training on performance-related physical fitness variables in male football players. *CBÜ Journal of Physical Education and Sports Sciences*, 11(2), 77-82.

D'Isanto T, D'Elia F, Raiola G, & Altavilla G. (2019). Assessment of sport performance: Theoretical aspects and practical indications. *Sport Mont,* 17:79–82. https://doi.org/10.26773/smj.190214

Doğan Ö. (2018). *12-14 Age Group Male Basketball Players in 12-14 Age Group The Effects of 8-Week Corrective Training Programme on General Strength, Balance and Psycho-Motor Achievement Level.* Master Thesis. Gazi University Institute of Health Sciences.Ankara.

Draper J. (1985). The 505 test: a test for agility in horizontal plane. *Aust J Sci Med Sport*, 17:15–8.

Drinkwater EJ, Pritchett EJ, & Behm DG. (2007). Effect of instability and resistance on unintentional squat-lifting kinetics. *International Journal of Sports Physiology And Performance*. 2(4), 400-413. https://doi.org/10.1123/ijspp.2.4.400

Faude O, Koch T. & Meyer T. (2012). Straight sprinting is the most frequent action in goal situations in professional football. *J Sports Sci*, 30:625–31. https://doi.org/10.1080/02640414.2012.665940

Gezer, B. (2020). *The Relationship Between Reflex Contraction and Explosive Power, Sprint and Eccentric Strength Parameters of Hamstring Muscle Group in Adolescent Footballers.* Master's Thesis, Istanbul University, Istanbul.

Gıssıs, I., Nıkolaıdıs, D., Papadopoulos, C. & Papanıkolaou, Z. (2003). *Maximal Isometric Force and Cycling Speed in Young Male Soccer Players*. Communication to the Fifth World Congress of Science and Football, Madrid: Editorial Gymnos, 142.

Gök B. (2021). *The Effect of 6-Week Static and Dynamic Core Exercises on Physical Performance Parameters in Young Boxers*. Master's Thesis. Institute of Postgraduate Education, Çanakkale Onsekiz Mart University, Çanakkale.

Günay, M., & Yüce, A.İ. (2008). *Scientific Basis of Football Training.* Gazi Bookstore.

Gür F. (2015). *Evaluation of the Effect of Core Training on Core Strength, Static and Dynamic Balance Properties of 8-14 Age Group Tennis Athletes*. Master Thesis. Ankara University. Ankara.

Gürses, Ç., & Olgun, P. (1996). *Sportive talent research method (Turkey application).* Turkish Sports Foundation Publications, Istanbul, 76.

Handzel, T.M. (2003). Core training for improved performance. *NSCA's Performance Training Journal*, 2(6), 26-30.

Herrington, L., & Davies, R. (2005). The influence of pilates training on the ability to contract the transversus abdominis muscle in asymptomatic individuals. *Journal of Bodywork and Movement Therapies*, 9(1), 52-57. https://doi.org/10.1016/j.jbmt.2003.12.005

Hopkins W, Marshall S, Batterham A. & Hanin J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc*.; 41(1): 3-13. https://doi.org/10.1249/MSS.0b013e31818cb278

Hopkins WG (2000). Measures of reliability in sports medicine and science. *Sports medicine,* 30(1): 1-15. https://doi.org/10.2165/00007256-200030010-00001

Hoshikawa, Y., Iida, T., Muramatsu, M., Ii, N., Nakajima, Y., Chumank, K., & Kanehisa, H. (2013). Effects of stabilization training on trunk muscularity and physical performances in youth soccer players. *Journal of Strength and Conditioning Research*, 27(11), 3142-3149. https://doi.org/10.1519/JSC.0b013e31828bed36

Jeffreys I, Huggins S, & Davies N. (2018). Delivering a gamespeed-focused speed and agility development program in an English Premier League Soccer Academy. *Strength Condit J*, 40:23–32. https://doi.org/10.1519/SSC.0000000000000325

Kean CO, Behm DG, & Young WB (2006): Fixed foot balance training increases rectus femoris activation during landing and jump height in recreationally active women. *J Sports Sci Med*, 5(1), 138-148.

Kibler, W.B., Press, J. & Sciascia, A. (2006). The role of core stability in athletic function. *Sports Medicine*, 36(3), 189-198. https://doi.org/10.2165/00007256-200636030-00001

Koz, M., & Ersöz, G. (2010). The importance of physical and muscular fitness in preventing sports injuries. *The Journal of Clinical Orthopedics and Traumatology And Turkey Special Topics, 3*(1), 14-19.

Kurtay M. (2023). *The Effect of Static and Dynamic Core Training on Physical Performance in Football Players.* Doctoral Thesis, Institute of Health Sciences, Manisa Celal Bayar University, Manisa.

Mackenzie B (2005): *Performance evaluation tests.* USA: Peak Performance, 55-72

Majewskı-Schrage, T., Evans, T.A., & Ragan, B. (2014). Development of a Core Stability Model: A Delphi Approach. *Journal Of Sport Rehabilitation,* 23(2), 95-106. https://doi.org/10.1123/JSR.2013-0001

Maranci, B. & Muniroglu, S. (2001). Comparison of motoric characteristics, reaction times and body fat percentages of football goalkeepers and players in other positions. *Gazi Journal of Physical Education and Sport Sciences*, 6(3),13-26.

Mendes, B. (2016). The effects of core training applied to footballers on anaerobic power, speed and agility performance. *The Anthropologist*, 23(3), 361-366. https://doi.org/10.1080/09720073.2014.11891956

Meng X, Du M, & Ma X. (2009). Effect of core strength training on improving athletic ability of women sprinters. *J Shandong Inst Phys Educ Sports*, 25:66–81. doi: 10.3969/j.issn.1006-2076.2009.04.020

Mjolsnes, R., Arnason, A., Osthagen, T., Raastad, T. & Bahr, R. (2004). A 10-week randomized trial comparing eccentric vs. concentric hamstring strength training in well-trained soccer players. *Scandinavian Journal Medicine Science Sports*, 14, 311–317. https://doi.org/10.1046/j.1600-0838.2003.367.x

Moffroid M, Whipple R, Hofkosh J, Lowman E, & Thistle H (1969). A studyof isokinetic exercise. *Physical Therapy*, 49,7, 735-747. https://doi.org/10.1093/ptj/49.7.735

Nadler, S.F., Malanga, G.A., Bartoli, L.A., Feinberg, J.H., Prybicien, M. & DePrince, M. (2002). Hip muscle imbalance and low back pain in athletes: influence of core strengthening. *Medicine & Science in Sports & Exercise*, 34(1), 9-16. https://doi.org/10.1097/00005768-200201000-00003

Oshima T, Nakase J, Inaki A, Mochizuki T, Takata, Y, Shimozaki K, Kinuya S. & Tsuchiya, H . (2019). Comparison of muscle activity, strength, and balance, before and after a 6-month training using the FIFA11+ program (part 2). *Journal of Orthopaedic Surgery,* 28(1) 1–6. https://doi.org/10.1101/540492

Özkan. A., Arıburun. B., & Kin İşler A. (2005). Investigation of some physical and somatotype characteristics of American football players in Ankara. *Gazi University Journal of Physical Education and Sport Sciences*, 10(2): 35-42.

Parkhouse KL., & Ball N (2011). Influence of dynamic versus static core exercises on performance in field based fitness tests. *J Bodyw Mov Ther*., 15,4, 517-524. https://doi.org/10.1016/j.jbmt.2010.12.001

Prieske, O., Mühlbauer, T., Borde, R. A., Gube, M., Bruhn, S., Behm, D. G., & Granacher, U. (2015). Neuromuscular and athletic performance following core strength training in elite youth soccer: Role of instability. *Scandinavian journal of medicine & science in sports*, *26*(1), 48-56. https://doi.org/10.1111/sms.12403

Raya, M.A., Gailey, R.S., Gaunaurd, I.A., Jayne, DM., Campbell, SM., Gagne, E., & Tucker, C. (2013). Comparison of three agility tests with male servicemembers: Edgren Side Step Test, T-Test, and Illinois Agility Test. *J Rehabil Res Dev*, 50(7), 951-960. https://doi.org/10.1682/JRRD.2012.05.0096

Reılly, T., & Gılbourne, D. (2003). Science and football: A review of applied research in the football codes. *Journal of Sports Sciences*, 21, 693–705. https://doi.org/10.1080/0264041031000102105

S Sannicandro, I., Specdicato, M., Palaia, G., Cofano, G., Bisciotti, G. N., & Eirale, C. (2015). Strength ability, endurance and anthropometric parameters in youth football: descriptive analysis and functional relationships. *Medicina dello sport*, *68*(1), 19-30.

Saeterbakken AH, Van den Tillaar, R. & Seiler, S. (2011). Effect of core stability training on throwing velocity in female handball players. *The Journal of Strength &Conditioning Research*, 25,3, 712-718. https://doi.org/10.1519/JSC.0b013e3181cc227e

Samson KM., Sandrey MA., & Hetrick A (2007). A core stabilization training program for tennis athletes. *Athletic Therapy Today*, 12,3, 41-46.

Sannicandro I, Cofano G, & Piccinno A. (2020). Can the Core Stability Training Influences Sprint and Jump Performances in Young Basketball Players? *Advances in Physical Education*, 10(03):196. https://doi.org/10.4236/ape.2020.103017

Şatıroğlu, S., Aslan, E., & Atak M. (2013). *Core training effect and study examples. Hacettepe University School of Sport Sciences and Technology*, 5th Training Science Congress, Beytepe/Ankara.

Sever O., & Zorba E. (2018). Comparison of effect of static and dynamic core exercises on speed and agility performance in soccer players. *Isokinet Exer Sci*, 26:29–36. https://doi.org/10.3233/IES-171120

Sevim, Y. (1995). *Training Information*, Gazi Office Bookshop, Ankara.

Sharma, A., Geovinson, S. G., & Singh, S. J. (2012). Effects af a nine week core strengthening exercise program on vertical jump performances and static balance in volleyball players with trunk instability. *The Journal of Sports Medicine and Physical Fitness*, 52(6), 606-615.

Shinkle J, Nesser T.W, Demchak T.J. & McMannus DM. (2012). Effect of core strength on the measure of power in the extremities. *J Strength Condit Res*, 26:373–80. https://doi.org/10.1519/JSC.0b013e31822600e5

Sighamoney R, Kad R. & Yeole UL. (2018). Effect of core strengthening on dynamic balance and agility in badminton players. *Int J Phys Educ Sports Health*, 5:86–8.

Standaert CJ, Weinstein SM., & Rumpeltes J (2008): Evidence-informed management of chronic low back pain with lumbar stabilization exercises. *The spine journal*, 8(1), 114-120. https://doi.org/10.1016/j.spinee.2007.10.015

Stanton, R., Reaburn, P. R., & Humphries, B. (2004). The effect of short-term swiss ball training on core stability and running economy. *The Journal of Strength and Conditioning Research*, 18(3), 522-528. https://doi.org/10.1519/00124278-200408000-00023

Steindler A. (1955). *Kinesiology of the human body under normal and pathological conditions*: Thomas.

Stolen, T., Chamarı, K., Castagna, C. & Wısloff, U. (2005). Physiology of soccer. *Sports Medicine*, 35, 501- 536. https://doi.org/10.2165/00007256-200535060-00004

Struzik, A., Pietraszewski, B., & Zawadzki, J. (2014). Biomechanical analysis of the jump shot in basketball. *Journal of human kinetics*, 42, 73. https://doi.org/10.2478/hukin-2014-0062

Suchomel TJ, Nimphius S, Bellon CR, & Stone MH. (2018). The importance of muscular strength: training considerations. *Sports Med*, 48:765–85. https://doi.org/10.1007/s40279-018-0862-z

Takatani A. (2012). *A correlation among core stability, core strength, core power, and kicking velocity in Division II college soccer athletes*. master's thesis, Pensilvanya Üniversitesi, California.

Tamer K., Uçan İ., Ozan M., & Buzdağlı Y. (2017). The Effects Of An 8-Week Basketball Traınıng On Some Physıcal And Physıologıcal Parameters In 11-14 Year Old Chıldren: *Asıan Academıc Research Journal Of Multıdıscıplınary*, Volume 4, Issue 12, Issn: 2319 – 2801.

Werasirirat P, Sutho T, Nakwaranon P. & Suntronchodchai K. (2022). Effect of core stabilization on agility, dynamic balance, and speed in short distance runners: a randomized placebo controlled pilot trial. *J Exer Physiol Online*, 25:10.

Weston M, Hibbs AE, Thompson KG, & Spears IR (2015). Isolated core training improves sprint performance in national-level junior swimmers. *Int J Sports Physiol Perform*., 10,2, 204-210. https://doi.org/10.1123/ijspp.2013-0488

Willardson, J.M. (2014). *Developing the core*. United states: National Strength & Conditioning.

Yang, Dae-Seung. (2014). Effects of 12 weeks core stability training on physical fitness and stability in taekwondo poomsae players. *The Official Journal of the Korean Academy of Kinesiology*, 16.3: 59-67. https://doi.org/10.15758/jkak.2014.16.3.59

Young WB. (2006). Transfer of strength and power training to sports performance. *Int J Sports Physiol Perform*, 1:74–83. https://doi.org/10.1123/ijspp.1.2.74

Young WB., & Bilby GE. (1993). The effect of voluntary effort to influence speed of contraction on strength, muscular power, and hypertrophy development. *J Strength Cond Res*, 7:172–8. https://doi.org/10.1519/00124278-199308000-00009

Yu H, Wang H, Peng C. & Jia J. (2008). The theory analysis about the relation between core strength training and traditional strength training: the core stability training. *J Tianjin Inst Phys Educ*, 23:509–11. doi: 10.19582/j.cnki.11-3785/g8.2007.03.001

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