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EFFECT OF AN EIGHT-WEEK CORE STRENGTH TRAINING ON SOME PERFORMANCE PARAMETERS IN FOOTBALL REFEREES

UČINEK OSEM-TEDENSKEGA TRENINGA MOČI NA NEKATERE PARAMETRE USPEŠNOSTI NOGOMETNIH SODNIKOV

ABSTRACT

The aim of this study was to examine the effects of eight-week core strength training (CST) in addition to specific trainings of football referees on sprint, agility and anaerobic power. Forty nine male football referees participated in the study. The subjects were divided into two groups as experimental group (EG, n = 24) and control group (CG, n = 25). An eight-week CST program was implemented in the EG. The CG subjects participated in their respective sport training routine. 10m., 20m sprint, pro-agility, vertical jump (VJ) and long jump (LJ) were measured both before (pre-test) and after (post-test) the eight weeks. Anaerobic power (AP) was calculated using Lewis formula. Paired samples t-test was used for statistical analyses. There were significant improvements in 10m, 20m, VJ and AP between pre-test and post-test of EG ($p<0.05$). However, no significance was found in pro-agility and LJ for EG groups ($p>0.05$). There were significant improvements only in 20m. sprint for CG between pre-test and post-test ($p<0.05$). It was found that the eight-week CST in addition to specific trainings of football referees had positive effects on their 10m., 20m. sprint and VJ jump. However, it was thought that this effect was not directly associated with CST and that this development occurred since referees already had an intense training program based on speed and anaerobic power. This thought was supported with literature. Core stabilization tests performed before and after CST to football referees in future studies will give positive results in terms of increasing the reliability of results.

Keywords: Core strength training; football referees; sprint; agility; anaerobic power

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IZVLEČEK

Namen pričujoče študije je bil preučiti učinke osemtedenskega treninga moči (CST) nogometnih sodnikov in njegov vpliv na šprint, agilnost in anaerobno moč. V raziskavi je sodelovalo 49 nogometnih sodnikov. Preiskovanci so bili razdeljeni v dve skupini: i) eksperimentalna skupina (EG, n = 24) in ii) kontrolna skupina (CG, n = 25). EG je izvedla osemtedenski program CST. Preizkovanci kontrolne skupine CG so izvajali normalne športne treninge. Meritve telesnega fitnesa (10 m., 20 m sprint, agilnost, vertikalni skok (VJ) in skok v daljino (LJ) so merili tako pred kot po intervenciji osmih tednov. Anaerobno moč (AP) smo izračunali s pomočjo Lewisove formule. Za ugotavljanje razlik med skupinami smo uporabili t-test za odvisne vzorce. Pri eksperimentalni skupini smo opazili značilne razlike v pre- in post- testu ($p <0,05$) v naslednjih testih telesnega fitnesa: 10 m, 20 m, VJ in AP. Ugotovili smo, da dodatni osemtedenski trening moči nogometnih sodnikov pozitivno vpliva na izboljšanje naslednjih testov telesnega fitnesa: 10 in 20 m sprint in vertikalni skok. Ugotovili smo, da omenjene izboljšave telesnega fitnesa neposredno povezane s treningom moči in da je do tega prišlo, ker so sodniki v preteklosti že imeli intenziven program usposabljanja, ki temelji na hitrosti in anaerobni moči.

Ključne besede: trening moči; nogometni sodniki; sprint; okretnost; anaerobna moč

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INTRODUCTION

The physiological characteristics of football referees have received an increasing amount of focus in the scientific literature over the past decade (Weston, Helsen, MacMahon & Kirkendall, 2004). Studies have examined referee profiles, both physiological and anthropometric (Rontoyannis, Stalikas, Sarros & Vlastaris, 1998) as well as the movement patterns and physiological load experienced during match (D'ottavio & Castagna, 2001; Helsen & Bultynck, 2004; Kurstrup & Bangsbo, 2001; Krustrup, Mohr & Bangsbo, 2002). Researchers have reported that football referees cover approximately 11500 meters (m) consisting of 1000 m. walking, 4200 m of low intensity running, 2600 m of medium-intensity running, and 1560 m of high intensity running during an average of 95 minute long match (Weston & Brewer, 2002). At the same time, heart rate recordings collected during matches have shown that mean cardiovascular strain imposed on referees during match is approximately 85-90% of maximal heart rate (Weston & Brewer 2002; Krustrup & Bangsbo, 2001). As the physical load which is imposed on elite-class referees during match is high (Krustrup & Bangsbo, 2001; Bangsbo, Nørregaard & Thorsoe, 1991) fitness levels need to be sufficient enough for the referees to be able to cope with the demands of games through keeping up with play at all times and ensuring optimal viewing positions (Weston, Helsen, MacMahon & Kirkendall, 2004).

There are many training programs to improve sporting performance and protect from injuries. One of them is core strength training (CST). The core has been described as a muscular corset with the abdominals in the front, erector spinae and gluteals in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature in the bottom (Akuthota, Ferreiro, Moore & Fredericson, 2008) and core stabilization has been described as the stabilization of the body center against the dynamic movements of limbs and the absorption of the pressures on core of the body (Ezechieli et al., 2013). Thus, this complex process involves actions of central nervous system, motor sensory and biomechanical system (Mikołajec & Rzepka , 2007) As is known, core exercise and training programs have become significant in sports fitness level and athletic performance enhancement (Sever & Zorba, 2016) Related researches have shown that since the core is regarded as the center of the kinetic chain in exercise and sport activities, it can be said that the core power, balance and movement control will maximize the functions of lower and upper extremities (Mikołajec & Rzepka , 2007; Sever & Zorba, 2016) According to this information, core CST can be expected to develop motor skills such as strength, coordination, speed, agility, balance, endurance etc. in all sportive activities and exercises (Anderson & Behm, 2005). Recently researches have investigated the effect of core strength training (CST)

on athletic performance and sports conditioning (Reed, Ford, Myer & Hewett, 2012; Nesser, Huxel, Tincher & Okada; 2008; Cissik, 2018). These researches have been shown that CST plays an important role in reducing and preventing lower and knee joint injuries (Leetun et al., 2004; Willson, Dougherty, Ireland & Davis, 2005; Zazulak et al., 2007), at the same time improving athletes' performance (Saeterbakken, Van den Tillaar & Seiler, 2011; Schilling, Murphy, Bonney & Thich, 2013; Stanton, Reaburn & Humphries, 2004; Tse, McManus & Masters, 2005).

Researchers have examined the physical and physiological characteristics of football referees, but no studies have been found about the effect of CST on football referees in related literature. Thus, the aim of the present study was to investigate the effect of eight-week CST on some performance parameters in football referees. Our study hypothesized that CST would contribute positively to some performance parameters such as sprint, agility and anaerobic power.

METHODS

Experimental Design

The present study is comprised of eight weeks of CST. A test-retest design with a control group (CG) was used to identify the effects of the CST. A total of 5 meetings were made with the subjects. In the first meeting, all of the subjects were informed about the measurements to be performed and in addition CST exercise program to be conducted was introduced to the Experimental Group (EG). The second and the third meetings included pre-test measurements for both CG and EG. In the second meeting, 10 m. and 20 m. sprint tests were conducted on the groups, while pro-agility VJ and LJ tests were conducted in the third meeting. AP was calculated with VJ results. Fourth and fifth meetings were the subjects' post-tests. Post-tests of 10 m. and 20 m. sprint were completed in the fourth meeting, while post-tests of pro-agility and anaerobic power were completed in the fifth meeting.

Measurements were performed at the same time on each day (between 16:00 and 20:00). Exercise and high-intensity physical activity were not allowed before meetings. Between the pre- and post-tests, the eight-week CST program was implemented in the experimental group (EG), while EG subjects continued in their usual sport training routine. At the same time, CG subjects were instructed to only participate in their usual training routine. The present study was designed and implemented in accordance with the Declaration of Helsinki (World Medical

Association, 2013). The study protocol was approved by the Ethics Committee of Ondokuz Mayıs University (B.30.2.ODM.0.20.08/1454-1504-1583).

Participants

The subjects for this study consisted of fourty nine Turkish football referees who were separated into two groups according to classification. The first group, which was the EG, consisted of 24 Turkish referees (age 30.85± 4.60) who were also listed in B and C classification in Turkish Football Federation (TFF). The referees had 9 ± 4.56 years of experience refereeing within their own country. The second group, which was the CG, consisted of 25 Turkish referees (age 23.80± 2.73) who were also listed in amateur classification in TFF. The referees had 4.04± 3.83 years of experience refereeing within their own country. These referees were affiliated with the TFF.

Table 1. Comparison of descriptive statistics of experimental and control groups.

	Group	n	Mean	SD	t	p
Age (year)	EG	24	30,85	4,60	6,509	**<0,001**
	CG	25	23,80	2,73		
Height (cm)	EG	24	179.23	6,72	-,308	0,759
	CG	25	179.28	7.11		
Weight (kg)	EG	24	71,38	7,22	,332	0,67
	CG	25	76,00	9,81		
Years in refeering (years)	EG	24	9,00	4,56	,136	**<0,001**
	CG	25	4,04	3,83		
VKİ (kg/m^2)	EG	24	22,27	1,12	,115	0,08
	CG	25	23,53	1,94		

Procedures

10 m. and 20 m. sprint

Sprint tests measured in the study were determined as 10 m. and 20 m. sprint tests. The measurements were performed on the tartan course on which the subjects trained regularly. The data from the photocell was directly transferred to the computer with a Tagheuer CP-540. After the photocell system was tested, the subjects were taken to the area.

The participants were made to start from 0,5 meter behind the photocell to prevent possible early starts. The measurements were determined as 10 m. and 20 m. respectively and 15-minute

long intervals were given between two sprints so that the athletes could have a complete rest. The subjects tried each test twice and the best results were recorded in second (sec).

Pro-agility test

A pro-agility test, also known as a 20 yard (18.2982 m) sprint, was conducted on the subjects. The test area was adjusted by placing pointers 4.57 m left and 4.57 m right of the start line. Tagheuer HL-232 photocell doors, which can record percentiles of a second, were placed at the start line and the area in which the study would be conducted was defined with pointers. The data from the photocell was directly transferred to the computer with a Tagheuer CP-540. After the photocell system was tested, the subjects were taken to the area. They were told that the participant had to be in place at the start line and, when he was ready, to touch the pointer on the right and then the one on the left at the same time with hands and feet and to end the test by passing the start line. After being shown how to do the test, each subject had to do a trial test three times and received feedback. At the beginning, the subjects to be tested were determined randomly and the test was predicted to be completed according to that order. All the subjects were tested three times with intervals of 1 minute. The subjects were given feedback to help them get the best results. The subjects' best times from these three tests were recorded in seconds (sec) and the test was concluded.

Vertical Jump and Anaerobic power

The participants' vertical jump was measured with VJ test. The measurements were performed by using TKK 5406 Jump meter vertical jump measurement device. The subjects were placed on the round base of the jump meter with their bodies completely vertical and the jump meter was calibrated; later, the subjects were made to jump vertically by bending their knees 90 degrees with their hands in free position. 3 vertical jumps with intervals of 1 minute were taken from all subjects and the best result was recorded in seconds. The subjects' anaerobic power was calculated by using Lewis formula (Anaerobic Power (Watt)= √4.9 x Body weight (kg) x √vertical jump (m) x 9.81) (Fox Bowers Foss., 1988).

Long Jump

Long jump measurements of the subjects were made by making the subjects jump forward from standing position without taking speed and both legs interrelated with each other. The heel point of the subject was measured in cm in the distance between the starting point and the finish and recorded as long jump data.

CST program

The CG subjects did not receive the CST protocol. They were instructed to maintain their respective sport training routine. The EG subjects received a CST program that consisted of eleven core-related exercises performed for eight weeks, while they continued in their usual sport training routine. The CST frequency was two times per week. CST program was not applied on the subjects incrementally and it continued with the same layout for 8 weeks. Eleven core-related exercises implemented within the CST program were as follows: (1) One arm/leg plank balance (10 right - 10 left) repetitions, (2) Side plank, triangle crunches (right side, left side) each 20 seconds, (3) plank (Elbow plank) 30 seconds, (4) Reverse elbow plank 30 seconds, (5) cobra exercies 30 seconds, (6) (Side plank, triangle crunches)30 seconds, (7) walk over (Backbends exercise) 30 seconds, (8) cross sit-up 30 seconds, (9) sit-up 20 repetitions, (10) Feet hard assisted superman exercies 15 repetitions, (11) hamstring exercise (Push-ups, jump-inside the lines) 6 repetitions. All of the moves were made in two sets and the rests were 15 seconds between moves and 60 seconds between sets. Five minutes of walking or jogging and 5 min of static stretching for major muscles were practiced to warm-up and cool-down (Özdal, 2016). All EG subjects received a hard copy that included instructions, pictures, and key points of the exercises.

Statistical analyses

SPSS program (SPSS for Windows, version 22.0, SPSS Inc., Chicago, Illinois, USA) was used for statistical analyses. The data were presented as mean and standard deviation. Shapiro–Wilk test was used for normality; Levene's test was used for the homogeneity. Skewness and kurtosis values were checked for data sets that were not normally distributed, and those which were within ±2 were accepted to be normally distributed The paired sample t-test was used to compare pre and post test for each groups. In addition, in the comparison of paired groups, effect sizes were found according to Cohen's d effect size ($M_2 - M_1)/SD_{pooled}$). According to this formula, a d value of <0.2 was defined as weak effect size, while a d value of 0.5 was defined as moderate and a d value of >0.8 was defined as strong effect size. The statistical results were assessed within significance level of $p<0.05$.

RESULTS

There was no significant difference between EG and CG in terms of demographic information such as height, weight, body mass index ($p>0.05$). However, significant differences were found in age ($p<0.01$) and years in refereeing between EG and CG ($p<0.05$) (Table 1).

Table 2. Differences in some performance parameters between EG and CG in pre-test and post-test.

		EG (n: 24)			CG (n: 25)		
		Mean±SD	**PC**	**e.s**	**Mean±SD**	**PC**	**e.s**
10 m. (sec)	Pre-test	1.79±0.10	%1.12	0.21	1.75±0.15	%0.54	0.16
	Post-test	1.77±0.9†			1.74±0.15		
20 m. (sec)	Pre-test	3.23±0.22	%0.9	0.13	3.20±0.24	%1.26	0.17
	Post-test	3.20±0.21†			3.16±0.22†		
Pro-Agility (sec)	Pre-test	5.27±0.24	%0.76	0.18	5.86±0.49*	-%2.65	0.26
	Post-test	5.23±0.20			6.02±0.68†,**		
VJ (cm)	Pre-test	44.50±4.33	%3.07	0.33	45.40±8.41	-%0.7	0.03
	Post-test	45.87±3.72†			45.08±9.11		
AP (Watt)	Pre-test	105.47±13.06	%1.64	0.13	113.22±19.73	-%0.65	0.03
	Post-test	107.20±13.71†			112.48±18.95		
LJ (cm)	Pre-test	198.11±12.39	%1,63	0.24	188.30±17.10*	-%0,53	0.07
	Post-test	201.35.±14.04			187.12±14.10†,**		

† significant difference between pre-test and post-test;* significant difference in pre-test between EG and CG;**significant difference in post-test between EG and CG; SD standard deviation; e.s cohen'd effect size; PC percentage change between pre-test and post-test; VJ vertical jump; LJ long jump; AP anaerobic power.

When pre-tests of EG and CG were compared, significance was found in pro-agility and long jump ($p<0.05$), but no significance was found in other parameters ($p>0.05$). When post-tests of EG and CG were compared, there were significant differences in pro-agility and long jump, as in pre-test ($p<0.05$); however, no significance was found in other parameters ($p>0.05$). Significances were found in EG between pre-test and post-test in 10 m., 20 m., VJ and anaerobic power ($p<0.05$), however there were no significance in pro-agility and long jump ($p>0.05$). On the other hand, significance was determined in 20 m. in CG ($p<0.05$), but no significances were found in 10m. and anaerobic power ($p>0.05$). There was signifance in pro-agility and long jump in CG ($p<0.05$), but this signifance was not positive. These results showed that CST applied on EG had positive effects on 10m., 20m. and anaerobic power levels. In addition, it was found that the only positive development in CG occurred as a result of 20 m. sprint test. It was found that CST applied on EG had positive effects on pro-agility and long jump, although not

statistically significant; however, negative development, that is, negative results were found in pro-agility, anaerobic power and long jump parameters of CG.

DISCUSSION

Scientists have hypothesized about the significance of core stabilization and core area for high performance, endurance and success in sport and as a result of their hypotheses, they have proven that individuals with strong core muscles and high core stabilization stand out in some physical and physiological parameters (Sever & Zorba, 2016; Schilling, Murphy, Bonney & Thich, 2013; Özdal, 2016; Ozmen & Aydogmus, 2016; Prieske et al., 2016; Sharrock et al., 2011; Okada, Huxel, & Nesser, 2011). Also, the number of studies which examine the association between core stabilization and core area strength and athletic performance has increased (Ozmen & Aydogmus, 2016; Prieske et al., 2016; Sharrock et al., 2011; Okada, Huxel, & Nesser, 2011), while the effects of CST on athletic performance in some branches and areas which require intense athletic performance and endurance have not been examined yet. One of these areas is football referees. The present study examines the effects of eight-week long CST on 10 m, 20 m sprint, pro-agility, anaerobic power and long jump in football referees.

Three major results were found in the study: that CST decreased the 10 m and 20 m sprint times and increased anaerobic power ($p<0.05$). The results also showed that CST decreased pro-agility period and increased long jump distance; however, these results were not significant ($p>0.05$).

It was found that some of the studies examining the effects of CST on athletic performance showed similar results with the results of our study. For example, Prieske et al. (2016) reported that 9-week long CST applied to young football players on stable area developed 10 m and 20 m sprint times positively, while no significant development was found in agility performance. Sever and Zorba (2016) reported that 8-week long static and dynamic CST did not have an influence on football players' agility. Hoshikawa et al. (2013) found progress in the 15 m sprint distances of 12-13 year-old adolescent football players with 6 month/ 4 sessions/week CST they applied. Similar to the results of our study, these studies also showed progress in sprint distance in CG; however, this progress was not as high as EG. In the present study, statistical progress was found only in 20 m. sprint times in CG. However, Schilling et al. (2013) reported that 6 week (2 sessions/week) CST they applied on college students did not have an influence on

sprint and agility. These results show that increasing CST time and intensity in addition to specific trainings had a positive influence on sprint and agility times, while short time CST did not have a statistical effect, especially on agility performance, but had positive effects on sprint performance, although not as much as the effect in long-term and intensity CST. In addition, some researchers found a moderate level of correlation between core area strength and sprint and agility (Nesser, Huxel, Tincher & Okada, 2008; Okada, Huxel, & Nesser, 2011; Nesser & Lee, 2009). Some researchers suggested that strength training may not be the only contributor to these performance markers (Schilling, Murphy, Bonney & Thich, 2013; Ozmen & Aydogmus, 2016). They stated that especially agility type exercises should be added to strength training programs and longer training programs might be needed for significant improvements. Agility has been defined as the ability to maintain a controlled body position and rapidly change directions without loss of balance (Raya et al., 2013; Sharma, Geovinson & Singh, 2012), and so strong core muscles are required during rapid movements of upper and lower extremities in different directions, but strong core muscles have no direct effect on this performance marker. The results of the present study showed that CST increased long jump distance, but this increase was not found to be statistically significant ($p=0.061$). This result was close to statistical significance. In their study, Sharma et al. (2012) reported a positive influence of 9 week (5 sessions/week) CST on jump performance (i.e., reach difference in jump and reach test) of volleyball players, while they reported similar results between CG and EG in spike jump and squat jump performances. The results of our study showed that CST applied on EG developed VJ ($p<0.05$), anaerobic power measured by VJ showed positive significance for EG. Some studies examining the effects of CST on VJ and anaerobic power showed that different types of core exercise developed VJ, but this development was not statistically significant (Nesser, Huxel, Tincher & Okada, 2008; Schilling, Murphy, Bonney & Thich, 2013; Tse, McManus & Masters, 2005). In addition, Nesser et al. (2008) found high correlation between total core score and VJ ($r=0.59$, $p<0.01$), while Sharrock et al. (2011) found a correlation between core strength and VJ ($r=540$, $p<0.01$). Although these results are not completely in parallel with the results of our study, this high correlation between CST and VJ proves that these two units are closely related with each other. In addition to these, Granacher et al. (2014) reported that eight weeks of strength training, including leg press, leg extension/flexion, calf raise, hip abduction/adduction and back squat exercises significantly increased jumping height and the American College of Sports Medicine (ACSM) has suggested that properly designed and supervised strength training programs may enhance motor fitness skills (e.g., jumping, sprinting) and athletic performance (Benjamin & Glow, 2003). Based on this information, it

was thought that adding CST in some specific strength training, especially adding lower extremity strength training, would have a direct influence on VJ and thus anaerobic power. Ozmen and Aydogmus (2016) also stated that CST added in lower extremity training could have an influence on static and dynamic postural control. These views of the researchers were also in parallel with our results. In general, when considered with the support from literature, it was thought that CST did not have a direct influence on athletic performance and that extra CST applied with training models and branch specific training could have a positive influence on performance. Cissik (2011) stated that if the purpose of strength conditioning coach is to develop the athletic performance, there is no need to emphasize core exercises much. Sever and Zorba (2016) said that core exercise applications can rarely take place in isolation. They rather represent a part within a whole physical fitness program routine. In this respect, it is not surprising that there are studies in which there is improvement in the athletic performance. In general, the multi-modal and complex exercise programs including core, balance, strength had a positive effect on various performance characteristics. In their study they conducted on the association between core and performance, Reed et al. (2012) argued that the majority of positive performance developments achieved in 13 out of the 24 studies were due to the exercises and measurements specific to the sports. It was also stated that the improvement in general strength, sprint and jump performance were not verifiable enough. Other studies claimed that the CST and core stabilization do not directly affect performance tests (Stanton, Reaburn & Humphries, 2004; Scibek, 1999). The comments of all these researchers supported our views.

CONCLUSION

As a conclusion, it was found that 8-week long CST applied in addition to specific training of football referees had positive effects on 10m., 20m. speed and VJ jump performance parameters. However, it was thought that this effect was not directly associated with CST and that this progress occurred since referees already had an intense training program based on speed and anaerobic power. This thought was supported with information from literature. All this information brought to mind that CST had indirect contribution to referees' athletic performance and that regular CST programs added in periodical referee trainings could make positive contributions to referees' athletic performance. In addition, it was thought that specific CST would develop not only athletic performance, but also core muscles and would have a

positive influence on core stabilization. This positive influence will increase the association between core stabilization and athletic performance which already has a high correlation. For this reason, core stabilization tests performed before and after CST on football referees will give positive results in terms of increasing the reliability of the results of studies.

Declaration of Conflicting Interests

This project was not directly supported by any grants or other financial assistance. The authors have no conflict of interest.

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