EVALUATION OF BALANCE, PROPRIOCEPTION, AND PHYSICAL PERFORMANCE PARAMETERS OF SOCCER REFEREES IN DIFFERENT CLASSIFICATIONS

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ABSTRACT

The aim of this study is to examine the relationship between proprioception and balance values of soccer referees in different classifications and certain physical performance values. In the present study, 60 male soccer referees working at Turkish Football Federation were voluntarily involved. The referees were divided into 3 groups based on their classifications [(national referees n=20, regional referees n=20, candidate referees n=20]. The soccer referees were taken to anthropometry, proprioception (30°, 80°, and 130° angles of shoulder joint), balance, elasticity, jumping, and agility tests. One Way ANOVA test was implemented for data analysis. Post hoc Tukey test was used for investigating from which the intergroup different originated. The differences between national referees and second referees were examined using Mann Whitney U test. The elasticity test results were found to be 27.43±10.95 for national referees, 28.40±7.64 for regional referees, and 34.85±6.05 for candidate referees. The candidate referees were found to be statistically significantly more elastic than regional referees and national referees (p=0.015). The agility test results were found to be 2.44±0.10 for national referees, 2.58±0.13 for regional referees, and 2.51±0.14 for candidate referees. The national referees were found to be statistically significantly more agile than regional referees (p=0.004*). In conclusion, it was determined that more frequently implemented agility and reaction exercises and having them a part of training offered the national referees a better agility times. Proprioception is an effective way of preventing the injuries. Proprioception exercises are believed to increase the environmental control and field perception of referees.*

Key words: *Soccer Refereeing, Proprioception, Kinesthetic Balance, Agility*

INTRODUCTION

Soccer is a team sport, which requires physical strength and in which the players aim to gain the ball within the scope of rules set by FIFA. The role of

referee in the game is to apply the rules for a proper game. For this purpose, the referees should have the sufficient physical fitness in order to make the right decisions by taking the right position throughout the game. In previous studies, it was determined that the games in different leagues require similar physical loads. In a study examining the differences between physical parameters of referees in super league and first league, it was reported that there was no statistically significant difference between the results (Bozdogan et al., 2016; Zelyurt et. all., 2015).

In today's soccer games, the referees run approximately 9-13 km during a game and accomplish the activity with 85-90% of hearth rate and 70-80% of maximal oxygen consumption. 4-18% of totally travelled distance is at high intensity. The blood lactate concentration generally varies between 4 and 5mmol/L, whereas it might increase up to 14mmol/L in the high-level official games. Referees reach at maximal oxygen consumption level of approx. 44-50mL/kg/min. These values are close to the values of midfield player. But, considering that a referee is approximately 15-20 years older, it can be said that the referees are exposed to higher loads throughout the game (Castagna et al., 2007).

A soccer game is played under supervision of a referee, two second referees, and a fourth referee. Upon the approval of federation, two assisting referees standing near the goal line are added into these referees.

Refereeing requires knowledge, experience, education, training, competence, muscular condition, control, and concentration, as well as the effort as high as players. For this reason, the visas of soccer referees are renewed, and several physical fitness tests are performed for upgrading to a higher classification. These tests include muscular performance, but they don't involve any sensory examination. Proprioception plays significant role in muscular control, movement accuracy, and joint stabilization. The joint position and movement direction are perceived via receptors in skin, muscle, meniscus, capsule, ligaments, and joints (Boerbooma et al., 2008; Lee et al., 2003). The balance can be defined as the skill of maintaining the body posture on support platform depending on the functional postural control system. This complex system includes visual, auditory, and somatosensory inputs. It also includes afferent dimension, and efferent dimension consisting of purposeful neuromuscular movements (Horak, 1997; Tittel, 1988).

According to Weinberg and Richardson (1990), the characteristic qualifications of a successful referee are consistency, competence, decisiveness, honesty, decision making, trust, and motivation.

In literature, there are limited studies on referees, and it can be seen that the studies have been mainly carried out on the physiological performances of referees. The aim of present study is to investigate if there is any difference between the referees working in different leagues in terms of proprioceptive sense and physical performance characteristics.

METHOD

60 male soccer referees working at Turkish Football Federation were voluntarily involved in this study. The referees were divided into 3 groups based

on their classifications [(national referees (KH) n=20, regional referees (IH) n=20, and candidate referees (AH) n=20]). The definitive statistics of referees are presented in Table 1. The ethical approval was obtained from Ethical Committee of Anadolu University. Prior to the tests, the subjects were informed about the tests and their informed consent forms were collected in written.

Table 1. *Definitive Statistics of Referees*

Soccer Referees (n=60)	National referee (n=20)		Regional referee (n=20)		Candidate Referee (n=20)		F	P
	Mean	SD	Mean	SD	Mean	SD		
Age (years)	30.00	3.84	25.45	3.45	20.55	2.76	39.114	.001**
Age of Training (month)	194.60	75.25	78.80	48.63	65.40	43.78	30.450	.001**
Height (cm)	179.78	5.70	179.74	6.83	177.24	5.12	1.206	.307
Body Weight (kg)	76.85	8.09	75.99	12.51	71.51	5.95	1.915	.157
Body Mass Index	23.50	1.75	23.39	3.42	22.64	1.46	.771	.467
Body Fat Index (%)	12.92	3.40	12.20	5.84	10.62	4.72	1.222	.302

*(*p≤0.05 **p≤0.01)*

Study Design

Anthropometry, proprioception (shoulder joint 30°, 80°, and 130°), balance, flexibility, jumping, and agility tests were applied to the referees.

The anthropometric measurements of referees were performed in laboratory in morning hours. And then, the referees were taken into proprioception, balance, and flexibility tests, respectively. Finally, they were taken into jumping and agility tests.

Anthropometric Measurements

The body weights of referees were measured using electronic laboratory scale for the barefooted referees wearing shorts. The body heights of athletes were measured using fixed stadiotmeter for the athletes standing in upright position and having body in anatomic position. They stood on the scale and sliding caliper was aligned to top of their head. Then the body height values were recorded. The body height and weight values were used for the statistical calculation of mean values (Lohman et al., 1988).

The body fat indices of referees were measured using bioelectrical impedance device. The barefooted athletes wearing a short were taken into tests in morning hours, when they were hungry and did not drink anything. This device delivers 50 kHz electrical current from hands to feet, and estimates the body fat percentage by measuring the total water content of body.

In bioelectrical impedance analysis, the device executes the measurement based on the electrical difference between the fatty and non-fatty tissues in body.

Elasticity measurement

The referees sat on the mat over the ground. Their soles were contacted to the platform of stand, and their knees were not allowed to bend. Then the referees were asked to reach ahead maximally and to push the ruler. The test was repeated for three times, and the best value was used for analysis.

Agility measurement

In Agility 505 Test, the referees ran for 5m forwards and then 5m backwards. Then, they performed 10m of approaching run. The referees started running from the start line in synthetic-floored athletics field. After the subject passed the start line by running 10 meters, then the chronometer started. Then the subject ran 5 meters more and, by returning backwards, passed through a photocell. The line that was start in beginning becomes the finish line at the end. The test was repeated for three times, 2 minutes of resting between the sessions, and the best time was used for analysis.

Squad and active jumping measurement

The squad jump (SS) and active jump (AS) heights of referees were measured by using a jumping mat and device measuring the time in air. The jumping tests were repeated for three times, and the highest jumping height was recorded for analysis. In SS test, the feet were widened at the shoulder width, the hands were placed on the waist, and the subjects jumped vertically starting from position. In AS test, the feet were placed with the same width with shoulders, the hands were placed on waist, and the subjects jumped vertically by having the knees reach at 90° squad position as immediately as possible. The referees were asked to get strength from hip and knees by placing their hands on their waist and to jump as high as possible.

Measurement of shoulder joint proprioception

The dominant shoulder joint proprioception of referees was measured concentrically in extension and flexion movements at 30°, 80°, and 130° angles. For the proprioceptive measurements, the subjects were laid flat, and their eyes were closed. The measurements were performed at the beginning, middle, and end of movement, and the proprioception measurement points were set at 30°, 80°, and 130°. The measurements were repeated for three times. In each session, the subject waited for 10 seconds at the target angle, and then was passively turned into initial position. And then, the subject was asked to find the target angle, and the resulting angle was recorded by using an isokinetic dynamometer. Calculating the angular difference between the recorded angles and the expected angle was calculated, and then the absolute value of angular errors in three angles.

Kinesthetic balance measurement

Static double-length balance measurements of referees were performed using kinesthetic balance device and on balance platform with bare feet. The balance platform was adjusted to 6PSI. The referees crossed their arms at the level of their chest and "X" cursor on the screen was aligned to the center point. The

referees were asked to stay in this position. The test was started in these conditions and automatically ended after 30 seconds.

Data Analysis

The statistical analyses of data were performed using SPSS 21 (IBM SPSS Statistics 21, IBM Corp, USA) software. The mean values and standard deviations were calculated for all the referees' data. The normal distribution of data was tested using Kolmogorov Smirnov and Shapiro-Wilks tests, whereas their homogeneity was calculated using Levene test. In order to determine if there is a difference between the test results, One Way ANOVA test was applied. Post hoc Tukey test was employed for examining which group the intergroup differences originated from. Mann Whitney U test was employed in order to determine if there was a difference between the national referees. The significance level of test results was set at $p \leq 0.05$, whereas the level of advanced significant difference was set at $p \leq 0.01$. The relationship between the tests was measured using Pearson Correlation test (Alpar, 2012).

RESULTS

The results obtained from 30° proprioception test were 1.05±9.10 for KH, 0.20±7.48 for IH, and 4.50±4.34 for AH (p=0.807). The results obtained form 80° proprioception test were 2.60±7.34 for KH, 0.05±4.39 for IH, and 0.30±3.48 for AH (p=0.242). The results obtained from 130° proprioception test were 0.35±7.41 for KH, 0.30±7.73 for IH, and 0.90±2.47 for AH (p=0.824). No statistically significant difference was found between the national referees, regional referees, and candidate referees in terms of shoulder proprioception tests at different angles.

For SS test, the findings for KH, IH, and AH were 31.30±5.47, 30.70±5.31, and 31.15±6.10, respectively (p=0.941). On the other hand, the results obtained from AS for the same parameters were 34.35±5.35, 33.35±6.03, and 34.20±6.25, respectively (p=0.846). No statistically significant difference was found between the national referees, regional referees, and candidate referees in terms of jumping heights.

In kinesthetic balance test, KH was found to be 213.35±57.32 and IH to be 205.05±51.78, whereas AH was determined to be 205.90±47.49 (p=0.859). In terms of KH, IH, and AH, no statistically significant difference was found in between the kinesthetic balance results of groups.

In terms of KH, no statistically significant difference was found between the proprioception, balance, and physical performance parameters and anthropometric characteristics of referees and second referees.

Table 2. *Mean Values and Standard Deviations of Elasticity Tests of National referees, Regional referees, and Candidate Referees*

Tests	Referees (n=60)	Mean	SD	F	p	Significant Difference
Elasticity (cm)	National referee (n=20)	27.43	10.95	4.547	.015*	Candidate Referee-Regional referee Candidate Referee-National referee
	Regional referee (n=20)	28.40	7.64			
	Candidate Referee (n=20)	34.85	6.05			

*(*p≤0.05 **p≤0.01)*

In Table 2, the elasticity test findings of referees by their classes are presented. The candidate referees were found to be statistically significantly more elastic than the regional referees and national referees (p=0.015*).

Chart 3. *Agility Test Mean Values and Standard Deviations of National referees, Regional referees, and Candidate Referees*

Tests	Referees (n=60)	Mean	SD	F	p	Significant Difference
Agility (sec)	National referee (n=20)	2.44	0.10	6.022	.004*	National referee – Regional referee
	Regional referee (n=20)	2.58	0.13			
	Candidate Referee (n=20)	2.51	0.14			

*(*p≤0.05 **p≤0.01)*

In Chart 3, the agility test results of referees are presented. National referees were found to be statistically more agile than regional referees (p=0.004*).

Negative and weak relationship was found between body weight and agility (r=-0.292*, p=0.024), while there were negative and weak relationship between body fat percentage and elasticity (r=-0.278*, p=0.032) and negative and weak relationship between age and elasticity (r=-0.409**, p=0.000). Second hypothesis was supported.

DISCUSSION

Many scientific researches have been carried out on athletes but in general, the studies carried out on referees concentrate on parameters such as heart rates, running distances, global positioning analyses, game activity analyses based on the positions, referee-assistant referee comparisons, spirometric tests, anthropometric measurements, endurance, speed, renewal, VO2max tests, reaction time tests, decision failure rates, aerobic-anaerobic capacities, physiological loads, energy consumption, fitness levels, different athletic tests (12-min running, 50m running, and etc.), lactate levels, and repetitive sprints (Aoba et al., 2011; Ardigo, 2010; Asami et al., 1988; Bartha et al., 2009; Castagna et al., 2002, 2004, 2005; D'ottavio and Castagna, 2001; Costa et al., 2013; 2007, 2008; Demir 2015; Eniseler et al.,

1999; Harley et al., 2002; Helsen and Bultynck 2004; Ishii et al., 2002; Bayansalduz, 2012, 2014; Kina 2015; Kizilet et al., 2010; Kizilet 2011; Sahin et. al., 2011; Polat et. al., 2009; Sahin et. al., 2012; Krustrup and Bangsbo, 2001; Krustrup et al., 2009; Mallo et al., 2008, 2009, 2012; Muniroglu et al., 1999; Ozdamar et al., 2011; Reilly and Gregson 2005; Silva et al., 2008; Silva and Nascimento 2005; Solomon et al., 2011; Sahan 2005; Tessitore et al., 2007; Weston, 2004, 2009, 2012; Yuktasir et al., 2003; Erdogan et. al., 2016; Ates et. al., 2017).

The presented study reports results that are similar with those reported by Kizilet et al. (2010). Kizilet et al. (2010) reported that the super league referees are older than second referees and national referees. The body mass index values were reported to be 24.80±1.39kg/m^2 for super league referees, 24.43±1.28 kg/m^2 for national referees, and 23.64±1.64 kg/m^2 super league second referees. In the present study, the national referees (30.00±3.84) are older than regional referees (25.45±3.45) and candidate referees (20.55±2.76). The body mass index values were calculated to be 23.50±1.75kg/m^2 for national referees, 23.39±3.42kg/m^2 for regional referees, and 22.64±1.46kg/m^2 for candidate referees. It is normal that the ages and training ages of referees vary depending on the classes of referees, because it takes long years to promote upper leagues and the referees get older.

The present study has similar results with the study carried out by Ozdamar et al. (2011). Ozdamar et al. (2011) examined the speed and jumping characteristics of national and regional referees. They reported no statistically significant difference between national referees and regional referees in terms of speed tests, repetitive sprints, and jumping heights. In the present study, statistically significant differences were found between the classes in terms of elasticity and agility, whereas no significant difference was found in terms of kinesthetic balance and jumping.

National referees, regional referees, and candidate referees do similar trainings for 70-90 minutes twice a week. In parallel with the study of Ozdamar et al. (2011), it can be thought that no difference could be found in come of performance parameters.

In the present study, the candidate referees were found to be more elastic than province and national referees. Given the idea that the elasticity decreases as the age advances, the elasticity might be prioritized more in trainings of national referees because, considering the training and game intensity of referees, an improved elasticity level is important for performance.

Aydemir (2008) reported that the implementation of proprioceptive training programs in treatment of injuries offers improvement in pain and functional status, as well as in sense of proprioception. Unver et al. (2005) determined no difference between the postural control level of healthy individuals and that of individuals undergone anterior cruciate ligament treatment.

Gern et al. (1998) emphasized that the sense of proprioception decreased after the repetitive ankle sprain, and that this lays the foundation of new sprains. Erden (2009) stated that the measured sense of joint position varied depending on the proprioception tests performed with knee positioned at 15°, 30°, 60°, and 90° flexion.

Esen et al. (2013) reported that regular exercises improved the proprioceptive responses of dancers. Can and Ikiz (2013) discussed the importance of proprioception training for the instability of ankle. They stated that the tools such as tilt board, wobble board, profitter, ankle disc, fitness ball, and BAPS (Biomechanical Ankle Platform System) or KAT (Kinesthetic Awareness Trainer) might be used.

Goksen et al. (2015) recommended the qualitative measurement of power by enabling training at full resistance via range of joint motion, strengthening exercises, balance, proprioception, aerobic exercises, and isokinetic dynamometer.

Akdogan (2011) compared the point position sense of dominant legs of folk dancers at 15°, 30°, 45°, and 60° with that of sedentary ones, and reported no statistically significant difference. In the present study, no significant difference was found between the proprioception values of different classes.

According to Krustrup and Bangsbo (2001), the referees change position every 4 seconds during a game, and the sum of position changes might reach at 1268 times in total. 588 of them are at low intensity, whereas 161 positon changes occur at high intensity. These 161 high intensity motions are the motions requiring agility within 2-3 seconds. In the present study, the national referees achieved better results in agility tests.

Castagna et al. (2005) found the age to be significantly effective on active jumping and 200m and 12-min running tests of elite level referees. Although the older group exhibited acceptable fitness levels, the younger group achieved better results in aerobic and anaerobic fitness tests. In the present study, no statistically significant difference was found between the classes in active jumping and squad jumping tests. Squad jumping test results were found to be 31.30±5.47 for national referees, 30.70±5.31 for regional referees, and 31.15±6.10 for candidate referees. In active jumping tests, the results were calculated to be 34.35±5.35 for national referees, 33.35±6.03 for regional referees, and 34.20±6.25 for candidate referees.

Sucan et al. (2005) compared the balance results of soccer players and sedentary individuals. The authors reported that the physiological system of soccer players ensuring the balance had better control, and that the exercise improved the balance parameter. Erdem et al, emphasizes that training programs with balance activities on agility is so important in their research (Erdem, et.all.,2015). In the present study, the results obtained from kinesthetic tests were calculated to be 213.35±57.32 for national referees, 205.05±51.78 for regional referees, and 205.90±47.49 for candidate referees. Even though no statistically significant difference was found, the national referees exhibit worse results. This might be explained with balance decreasing with the advancing age.

Kablan (2004) examined the shoulder joint proprioception among the volleyball players, and reported that the fatigue in proprioceptive senses is related with the experience but it solely doesn't influence the proprioceptive sense.

In the present study, no statistically significant difference was found between the shoulder joint proprioception values. In other words, the experience status such as training age or class was not found to be effective on proprioceptive skill. The proprioception perception, which is expected to increase as the age advances, showed no variation among the referees.

Gunaydin et al. (2016) compared the proprioception values of professional soccer players with those of sedentary individuals, and they reported no statistically significant difference. In the present study, similarly, no statistically significant difference was observed between the classes in terms of proprioception values.

In study of Kilavuz (2013), it was stated that there was no statistically significant relationship between balance skill and lower extremity performance level of young males. The balance skills were assessed using Flamingo balance test, functional reach test and portable computed kinesthetic balance device. In the present study, no statistically significant relationship was found between the agility and elasticity tests and kinesthetic balance tests.

In the present study, the main reason for finding no statistically significant difference between candidate referees and regional referees might be explained with the fact that there is no significant class difference between candidate refereeing and transition to regional refereeing. For this reason, the actual performances of candidate referees are normal because they start refereeing at younger ages and also they are significantly excited about promoting to higher class. Since the regional referees aim regional refereeing that is the first step of national refereeing and since not many referees can promote to this step of refereeing, the regional referees accept their performances. Moreover, since the Cooper test is the only athletic test applied to candidate and regional referees, it can be considered normal that their performance levels were found to be close to each other.

When the results of present study from the aspect of anthropometric characteristics, it can be stated that the elasticity decreases as the body weight and body fat percentage increase and, therefore, the referees should pay attention to their diets. In a previous study, it was reported that the high values of body weight, body fat percentage, and body mass index negatively affected the endurance results (Bozdogan et al. (2017).

CONCLUSION

According to the results of present study, no statistically significant relationship was observed between proprioception and agility tests. Considering how important agility is for a referee taking position during immediate movements, it can be recommended to pay importance to proprioception exercises and to analyze the studies more deeply from this aspect.

In conclusion, since the soccer rapidly advances nowadays, it is thought that various exercises might be implemented in order for referees to keep up with this advancement and to improve their performances. The national referees gained better agility times as a result of implementing agility and reaction exercises more frequently as a part of their trainings.

Within this context, it can be stated that the proprioception is an effective method in injury prevention program, and that it should be more frequently implemented in exercise programs of referees. Moreover, it is thought that the

proprioception exercises might improve the environment control and field perception of referees.

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