The effect of morphological characteristics on the physical and physiological performance of Turkish soccer referees and assistant referees

Tuba Kızılet Bozdoğan[1a], Ali Kızılet[1], and Bilal Biçer[2]

[1]Sport Science Faculty, Marmara University, Istanbul, Turkey
[2]School of Physical Education and Sports, Mustafa Kemal University, Hatay, Turkey

Abstract. Physical fitness and physiological status play an important role in the referees' performance. Therefore, the aim of this study was to analyze the body structure and morphological characteristics of Turkish Ssccer refereesand assistant referees and to determine the effect of these variables on physical performance. A sample of 158 male referees and 55 asisstant referees (mean age 31.8 ± 4.2 and 37.4 ± 3.3 years)was evaluated. Physical assesment were conducted using the Yo-Yo Intermittent Recovery Test Level 1 (YYIRTL1) and Repeated Sprint Ability (RSA) for referees and Active Recovery Intermittent Endurance Test (ARIET) and the RSA for assistant referees. We analyzed heart rate assesments. The measures used to assess morphological characteristics were age, weight, body mass index (BMI), body fat (BF), body mass, and fat free mass.The ANOVA test (Tukey test)was used to determine the result. Correlations between the referees' fitness test performance and their morphological characteristics were examined using Pearson's correlation ($p<0.05$). To result of this study, point to the existence of a strong correlation between morphological and physical and physiological characteristics. According to the literature, we found that greater BF and a higher BMI may negatively affect areferee's running performance.

Keywords: Anthropometry; Soccer Referee, Heart Rate, HRload

1 Introduction

During the game of soccer, footballers and referees are both active in field. They are important because soccer is very popular sports all around the world [31] and developing of the economy. While researchon referees has beenrather insufficient in the past,studies about their physical and mental competencies have increased by considering the effect on the results of the game today. Some of these are; anthropometric states [11, 33], including referee motion analysis, heart rate measurements [7, 41], physical activity intensity,and distance covered [16, 18]. These studies have contributed to the creation and design of refereetraining programs.

[a]Corresponding author: tuba.kizilet@marmara.edu.tr

Referees' and assistant referees'body composition is important for their performance. In soccer, body mass index (BMI), fat free mass '(FFM)' and body mass '(BM)' is associatedwith field performance [25]. Previous studies have shown that regular exercise reduces the BMI, FFM and body fat (BF) [22, 28]. Body composition is assessed as BF and lean body mass.

Gregory et. al [10] has shown that increasing of fat negatively affects athletic performance. However, Ugarkovic et. al [38] has found no correlation between body composition and performance.

During the gameplay, a distance of the referee's point with the rule infringement is the compatibility indicator with the game tempo [30]. Researchers have reported that a referee runsan average of 9-13 km during a match [3, 35] and an assistant referee runs about 6-8 km, and 1.2 km of it is by side runs. An elite referee is running average 110 high-intensity runs that take 2 s on average. In addition, it has been shown that an experienced referee faces similar physical demands as a midfielder [2]. In a study of Danish soccer players, midfield players have run averaged 1950±130 m. in the Yo-Yo Intermittent Recovery Test Level 1 (YYIRTL1) test [32]. According to the literature, this result is similar to referees covered distance.

The Repeated Sprint Ability Test (RSA) is a test widely used by sports scientists for soccer players and soccer referees. It is used to measure the referees' ability to recover after anaerobic performances during short rest intervals [8, 45]. Weston et al [42] found a correlation between the referees and footballer'shigh-intensity conditions ($p<0.05$).In similar research has been reported that the referee's adaptation to the game is influenced by the number of high-intensity players during a soccer match [24].

Referees must keep up with the pace of gameplay. As the economic importance of football increases,referees' and assistant referees' physical and physiological conditions becomingincreasinlyimportant. Referees are generally older than footballers. The referees reaching the elite level in their 40s.This means that there is usually a 15-20-year age difference between footballers and referees. Referees therefore require excellent physical and physiological health. The continuity and pursuit of training programs are important to the positive management of their performance. Therefore, the aim of this study was to analyze the body structure and morphological characteristics of Turkish soccer referees and assistant referees determine the effect of these variables on physical performance.

2 Material and methods

2.1 Participants

This study examined 158 male soccer referees (mean age 31.8 ± 4.2 years; training duration 12 years), from the Turkish Super League, First League, and Second League and 55 male assistant referees (mean age 37.4 ± 3.3 years; training duration 12 years), from the Turkish Super League and First League.

2.2 Procedures

The participants were evaluated on November 10-15, 2015. The tests were conductedin the morning.The tests were conducted in Istanbul to ensure that environmental factors and travel-related fatigue did not interfere with results. Referees performed a standard warm-up consisting of 5 min of slow jogging followed by 10 min of mobility exercises and 5 min of dynamic stretching.

2.2.1 Field tests

The tests were conducted on an artificial grass. All participants were subjected to physical assessments consistent with the test battery protocols.Referees were evaluated using the

YYIRTL1 and RSA (6x40 m), and assistant referees were evaluated using the Active Recovery Intermittent Endurance Test (ARIET) and RSA (6x40m). The tests for each test battery were done in two days. The YYIRTL1 test consists of intermittent exercises with maximal consumption of the aerobic system. It also shows the ability to recover after intense exercises [13]. The RSA is designed to test the subject ability to perform short-duration sprints, which occur frequently during gameplay. Recent studies have demonstrated a significant correlation (r= 0.65, r= 0.60) between sprints during gameplay and RSA results [29]. We used a heart rate monitor (Polar Heart Rate Monitor,Finland) to analyze physiological abilities. We evaluated HRload,HRmean and HRmax of the physiological parameters.

2.2.2 Antropometric measurements

Assessments of the chosen morphological characteristics (age, BM, BMI,BF, and FFM) were conducted in the early morning before breakfast.A bioelectrical impedance analyzer (Tanita-bc 418-ma) was used.

BF evaluation criteria is used for finding differences of groups. The evaluation references for BF were <%10, 10-12%, 12-14%, 14-16 %, >16% (13,14).

2.3 Statistics

Results are presented as means ± standard deviations (SD). The results of the tests were moderated, and the differences in the mean values were appraised through variance analysis (ANOVA), followed by the Tukey test for the identification of statistically significant differences among the equal of means. Correlations between the referees' fitness test performances and their morphological characteristics were examined using Pearson's correlation(r; $p<0.05$). Data analysis was performed using the Statistical Package for Social Sciences (version 21.0 for Windows, SPSS TMInc, Chicago, IL, USA). Statistical significance was set at $p < 0.05$.

3 Findings

Tables 1 and 3 shows the sample characteristics with the values of the mean and standard deviations by age, BM, BMI, FFM and BF percentage from referees and assistant referees, respectively.

Table 1. Referees' morphological characteristics, pyhsical/ physiological performance

	Mean	Standart Deviation	Max	Min
Age	31.85	4.2	42	23
BM (kg)	77	6.5	92.7	57.9
FFM (kg)	66.9	4.93	80	54.3
BF (%)	10.6	2.97	21.1	5
BMI	23.5	4.29	73.3	17.5
YYIRTL1 (m)	1607.3	296.6	2400	920
HRload	61.6	12.1	76	40
HRmax (beat/min)	186.7	10.5	205	167
HRmean (beat/min)	166.2	11.2	184.0	148.0
RSA (6x40m; sec)	36.6	2.40	48.1	31.8

BM: Body Mass; BMI: Body Mass Index; BF: % Body Fat; FFM: Fat Free Mass; Hrmax: MaxiumumHeart rate; HRmean: Mean Heart Rate

Both BF and BMI were negatively correlated with YYIRTL1 (Total distance) for Rs ($p<0.05$). There was also a negatif correlation between HRmean and BF. Additionally, age was negatively correlated with physiological ability ($p<0.05$). However, BF was positively correlated to the RSA performance (total time) and there was a positive correlation between BF and BMI.Nocorrelation was found between FFM, BM and the physical and pyhsiological abilities (Table 2).

Table 2. Correlations between morfological characteristics and referees' physical /physiological abilities

		Age	BM	FFM	BF(%)	BMI
YYIRTL1		–0.032	–0.024	0.042	–0.224**	–0.186*
	HRload	–0.464*	0.139	0.237	–0.345	–0.037
	HRmax	–0.476*	–0.285	–0.140	–0.445	–0.423
	HRmean	–0.603*	–0.169	0.053	–0.465*	–0.397
RSA(6x40m)		–0.093	0.080	–0.010	–0.262**	0.092

*P<0.05

Table 3. Assistant referees' morphological characteristics pyhsical/ physiological performance

	Mean	Standart Deviation	Max	Min
Age	37.4	3.3	45	31
BM (kg)	75.4	5.80	85.5	61.9
FFM (kg)	64.4	4.58	75.7	51.6
BF (%)	11.6	3.3	20.4	5.5
BMI	23.2	1.51	25.7	20
ARIET (m)	1782.8	140.6	1920	1240
HRload	47.5	6.7	56.0	34.5
HRmax (beat/min)	193.8	10.3	219	181
HRmean(beat/min)	178.4	11.0	198	160
RSA(6x40m; sec)	33.7	1.17	36	30

BM: Body Mass; BMI: Body Mass Index; BF: % Body Fat; FFM: Fat Free Mass; Hrmax: MaxiumumHeart rate; HRmean: Mean Heart Rate

Assistant referees BF was negatively correlated with RSA result.But no correlation was found between their BF and ARIET test results.There was also acorrelation between ARIET total distance with HRmean and HRload and age factor. ($p<0.05$) However,no correlations were observed between FFM, BM, BMI and the physical and physiological abilities considered in this study (ARIET and RSA; Table 4).

Table 4. Correlations between morfological characteristics and asisstant referees' physical /physiological abilities

		Age	BM	FFM	BF(%)	BMI
ARİET		–0.256	0.050	0.117	–0.214	–0.048
	HRload	–0.557*	0.210	0.298	–0.175	0.047
	HRmax	–0.120	0.190	0.046	–0.370	0.043
	HRmean	–0.269	0.242	0.042	–0.484*	–0.017
RSA(6x40m)		–0.253	–0.064	0.068	–0.329*	–0.139

*P<0.05

A statistically significant difference between the <10 BF% and 14.1-16.0 BF% referees in terms of RSA. A statistically significant difference was found YYIRTL1 test total distance between the individuals with <10 BF% and those with> 16 BF% in the referees. Individuals with low-fat percentages were found to covered longer distances. Additionally, a statistically significant difference to the total duration of the RSA test was found between the referees with 10.1-12 BF % and 16 BF% and those with <10 BF% and >16 BF% ($p<0.05$). However, no significant differences were observed in the YYIRTL1, ARIET and RSA results referees and assistant referees with other BF percentages ($p>0.05$) (Table 5).

Table 5. Comparison of physical abilities according to body fat variables

		Referees		Assistant Referees	
BF%	BF%	YYIRTL1	RSA(6 x 40M)	ARIET	RSA(6 x 40 M)
<10	10.1-12	.783	.143	.809	.794
	12.1-14	.566	.401	.873	1.000
	14.1-16	.147	.022	.990	.572
	>16	.010	.000	.513	.019
10.1-12	<10	.783	.143	.809	.794
	12.1-14	1.000	.910	1.000	.945
	14.1-16	.790	.968	.998	.967
	>16	.183	.085	.150	.185
12.1-14	<10	.566	.401	.873	1.000
	10.1-12	1.000	.910	1.000	.945
	14.1-16	.824	.476	.997	.762
	>16	.160	.003	.228	.085
14.1-16	<10	.147	.022	.990	.572
	10.1-12	.790	.968	.998	.967
	12.1-14	.824	.476	.997	.762
	>16	.765	.260	.477	.707

P<0.05

4 Discussion and conclusion

In this study, we described the morphological characteristics of elite referees and assistant referees and analyzed the influence of these variables on the physical performance. Results for both of the groups that we studied demonstrate a significant correlation between morphological and physical characteristics.

The accuracy of a referee's decisions during a match is related to the optimal closeness to the position.The ability to maintain performance throughout the game is influenced by physical and mental competence. Previous studies support our findings that BF, BM,and BMI values influence athletic performance [12, 37].

Referees must make correct decisions during gameplay; therefore, their physical characteristics are extremetely important as they affect performance [5]. Excessive body weight causes too much energy to be consumed during movement, and the fatty tissue creates a thermal insulation effect. Thisleads toan increase in dehydration. Which can cause the referee's movements to deteriorate during the game. Studies have shown that the ideal BF percentage in soccer is 7-12% [9].

In a study of footballers, it has documented that the BF% values were 11.64 ± 1.61 [27]. In previous studies were reported that BF percentages were 16.7% [33] of Greek referees and 20.7% [34] of Santa Catarina referees. However, referees' BF ratios must be in the ideal range to work at an elite level (<12%). Recent studies have shown that BF content is 11.6% [24]. Studies have reported values of 19.3 ± 4.1 [6] for Brazilian referees and 12.63 ± 4.2 [19] for South African referees. The present study found that the average percentage

of BF in referees and assistant referees was 10,6 % and 11.6%, respectively. Respectively, which suggests that the average Turkish referee is in ideal BF range.

Wilmore et.al.[44] have shown that the BMI is reported as a rough measure of body compositionand a good indicator of relative BF. Helsen and Bultynck [11] reported BMI values of 24.2 ± 2.6 kg/ m2European referees in 2000. Rontoyannis et al. [33] reported 25.9 ± 2.1 kg / m2 of Greek referees. and Reilly & Gregson [30] found British referees to have a BMI of 27.1 ± 5.3 kg / m2 and Krustrup et al. [18] also showed as 23 kg / m2.It is suggested that top-class referee's BMI values should be<25 kg / m2 [33]. The presented study, BMI is 23.5±4.29 kg/m2for referees and 23.2±1.51 kg/m2for assistant referees. According to ourresults, Turkish referees' BMI values seem to be better when compared to the literatures.

Studies by Weston et al. [39] and Castanga et al. [4] have shown that age has no significant effect on physical fitness and performance.The present study finds no statistically significant correlation between referees' age and physical characteristics ($p>0.05$).

The YYIRTL1 test scores has been shown to be consistent with the physical performance of elite-level soccer referees [27]. Previous studies using the YYIRTL1 test have documented the maximum distance covered by referees in Denmark (1.420 ± 90 m; 1). Belgium (1.720 ± 276 m; 43) and Italy (1.503 ± 399 m; 4).The present study found that the referees' average running distance of the referees was 1.607 ± 296 m.Additionally, a negative correlation was observed between referees' YYIRTL1 running distance and their BMI and BF percentage ($r = -224$ and $r = -186$. respectively).However, no correlation between the morphological characteristics and ARIET running distance ($p> 0.05$).

Several studies on referees' heart rates during a match have been conducted. Which have measured averages of 162–165 beats/min [30]. 163 ± 2 beats/min [17]. 161 ± 9 beats/min (in Italian referees; 21) and 163 ± 5 beats/min (in English Premier League referees; 7).A study conducted on British referees showed no correlation between mean heart rate and average distance in the match [41]. In a similar study conducted by Morris [24] HRmax values were shown as 189±8.61 beats / min and HRmean as 160.32±10.42 beats / min according to the YYIRTL1 test results.In the presented study, the referees' and assistant referees' HRmax, HRmean and HRload values were 186.7 ± 10.5 beats/min., 166.2 ± 11.2 beats/min., 61.6 and 193.8 ±10.3 beats/min., 178.4 ± 11 beats/min. and 47.5 ± 6.7, respectively.According our study test results, HRmean andBF percentage were a statistically significant in referees and assistant referees ($p <0.05$). Also,there was a significant difference between BF referencegroups and heart rate values ($p> 0.05$).

In a study, Mallo et al. [20] reported that there was no correlation between RSA performance and the distance the referees covered at high speed. A recent study has found that sprints in a match indicated a significant correlation ($r = -.65$. $r = - 0.60$) between high intensity running and RSA [26].

Our study has found a significant negative correlation between RSA total time and BF percentage for referees and assistant referees($r= -262$ and $r=-329$.respectively).In a similar study, there was a positive correlation with the decline in velocity performance between BM, FM and BF percentages [23]. This shows that an increase in total mass and fat mass is detrimental to speed [36].

In this study, we found that increases to BF percentage and BMI negatively affected referee running performance. Appropriate training strategies and nutrition should be recommended to the referees in order to promote optimal health and physical performance.

References

1. Bangsbo J. Mohr M. & Krustrup P. Journal of Sports Sciences.**22**(6): 524. (2004)

2. Bizzini M. Junge A. Bahr R. Helsen W. Dvorak J. Br J Sports Med.; **43**(7):490–7 (2009).
3. Castagna C. Abt G. D'Ottavio S. Sports Med.**37** (7):625–46 (2007).
4. Castagna. C. Abt. G. D'ottavıo. S. & Weston.M. Journal of Strength and Conditioning Research.**19**(4): 785-790 (2005a).
5. Catteeuw P. Helsen W. Gılıs. B. Wagemans. J. Journal of Sports Sciences; **27**(11): 1125–1136(2009).
6. Da Sılva. A. Fernandez. R. Paes. M. Fernandes. L. & Rech.C.Archivos De Medicina Del Deporte. (**144**): 238-246 (2011).
7. D'ottavıo. S. Castagna. C. J. of Srength and Conditioning Research. **15** (2). 167-171 (2001).
8. Fıtzsımons. M. Dawson. B. Ward D. & Wılkınson A. Australian Journal of Science and Medicine in Sport.**25**(4): 82-87 (1993).
9. Garret JR. William E. Kirkendall DT. Porto Alegre: Artmed(2003).
10. Gregory G. Haff. Travis Triplett N. National Strength and Conditioning Association 4. Th Ed. Human Kinetics (2016).
11. Helsen W. Bultynck JB. J Sports Sci; **22**: 179-89 (2004).
12. Housh TJ. Thorland WG. Johnson GO. Tharp GD. *Brit JSports Sc.***2**:3-11 (1984).
13. Iaıa. F. Rampınını. E. & Bangsbo. J. International Journal of Sports Physiology and Performance. 4: 291-306 (2009).
14. Jackson AS. Pollock ML. Phys Sportsmed.**13**:76–90 (1985).
15. NevillA.M. MetsiosG.S.JacksonA.S. Wang. J. ThorntonJ. and GallagherD. Int J Body Compos Res. **2**; 6(3): 114–121 (2008)
16. Johnston. L.; Mcnaughton. L.Aust J Sci Med Sport.**26** (3-4): 67-72 (1994).
17. Krustrup. P. & Bangsbo. J. Journal of Sports Sciences.**19**(11): 881-891 (2001).
18. Krustrup. P.; Helsen. W.; Randers. M. B.; Chrıstensen. J. F.; Macdonald. C.; Rebelo. A. N. & Bangsbo. J. Journal of Sports Sciences.**27**(11): 1167-1176 (2009).
19. L.Lategan African Journal for Physical. Health Education. Recreation and Dance.**17**(4): 675-693 (2011).
20. Mallo. J.; Navarro. E.; Garcıa-Aranda. J. & Helsen. W. Journal of Sports Sciences.**27**(1): 9-17 (2009).
21. Mallo. J.; Navarro. E.; Garcıa-Aranda. J.; Gılıs. B. & Helsen. W. Journal of Strength and Conditioning Research.**22**(1): 235-242 (2008).
22. Marandi MS. Abadi BN. Esfarjani F. Mojtahedi H. Ghasemi G. Int J Prev Med.**4**. 125 (2013).
23. Moncef C. Said M. Olfa N. Dagbaji G. Asian Journal of Sports Medicine.**3**:2. 74-80 (2012).
24. Morris B. 'Doctara Thesis:Stellenbosch University https://scholar.sun.ac.za.(2015)
25. Oliver MJ. Lambert SB. Martin ES. Green SJ. Crouse FC.J Athl Train. **47**. 263 (2012).
26. Oliver.O. Armstrong. N. Williams. C. International Journal of Sports Physiology and Performance.**2**: 137-149 (2007).
27. Osiecki R. Glir FG. Fornaziero AM. Cunha RC. Dourado AC. Rev Edu Física/UEM;**18**.177-82 (2007).
28. Rahimi R. Physical Edu Sport.**4**. 101 (2006).
29. Rampinini. E. Bishop. D. Marcora. S.M. Ferrari. D. Sassi. D.Impellizzeri. F.M. Int. J. Sports Med..**28**:228-235 (2007)
30. Reilly T. Gregson W. J Sports Sci.**24**(7):795–801 (2006).
31. Reilly T.J Sports Sci;**15**(3):257–63 (1997).
32. Reilly. T. Bangsbo. J. Franks. A**18**. 669± 683 (2000).
33. Rontoyannis. G. P.; Stalikas. A.; Sarros. G.; Vlastaris. A. Journal of Sports Medicine and Physical Fitness. **38**. 208-14 (1998).
34. Schwingel. A.C.; Mıchels. G.; Petroskı. E.L.; Velho. M.N. Anais do XXIm Simpósio Internacional de Ciências do Esporte. São Paulo. p. 77(1998).

35. Stolen T. Chamari K. Castagna C. Wisloff U. Sports Med.;**35**(6):501–36 (2005).
36. Stuempfle. K.J. Katch F.I. & Petrıe D.F. J. Strength Cond. Res. **17**.238–244 (2003).
37. Swain. DP. 9th ed. Baltimore(MD): Lippincott and Wilkins. s.342 (2014).
38. Ugarkovic. D. D. Matavulj. M. Kukolj. And S. Jaric. J. Strength Cond. Res. **16**.227–230 (2002)
39. Weston M. Drust B. Atkinson G. Gregson W. Int J Sports Med.;**32**(3):190–4 (2011)
40. Weston. M & Helsen. W. (3rd Ed) (Pp 271-285). Routledge: New York (2013).
41. Weston. M. & Castagna. C. Journal of Sports Sciences.**23**(11): 1302-1303 (2005).
42. Weston. M.; Castagna. C.; Impellizzeri. F.; Rampinini. E. & Abt. G. Journal of Science and Medicine in Sport.**10**: 390-397 (2007).
43. Weston. M.; Helsen. W.; Macmahon. C.; Kirkendall. D. The American Journal of Sports Medicine. Vol. **32** (1). 54s-61s (2004).
44. Wilmore JH. Costill DL. Human Kinetics. Campaign 145-152 (1999).
45. Wragg.C.B. Maxwell.N.S.Doust. J.H. J. Appl. Physiol.**83:** 77- 83 (2000).