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Aerobic fitness and body fat of elite Greek soccer referees

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Abstract

The aim of this study was to examine the aerobic fitness and the percentage of body fat (% BF) of elite Greek referees of the Super League. In the research project, the participants were sixteen men (mean age 36.4±4.9 years) and one female referee who were enrolled in the Referees technical committee (KEA-in Greek) of the Hellenic Soccer Federation (EPO). The results showed that the average of the maximum uptake of oxygen (VO₂max) for men was 51.7±6.4 ml/kg/min and for the female referee it was 44.1 ml/kg/min. Moreover, the results showed that older referees had higher aerobic fitness levels, implying that they can easily cope with game demands. The conclusion of this research is that Greek referees of the Super League have a satisfying level of aerobic fitness compared to foreign referees. Additionally, the average of men's body fat percentage was 15.3±2.8%, while for the woman it was 16.3%. Although the % BF for men referees is acceptable, further improvements will enhance their performance. Finally, for the female referee, her % BF was of good standards.

Keywords: VO₂ max, training years, performance, game, men, woman

1. Introduction

The role of a referee is of particular importance in a soccer game. Especially in professional soccer, a wrong decision can have serious consequences for the outcome of the game. In this context, proper knowledge of the laws of the game and a good physical condition of the referee can obviously benefit the match. Studies have shown that during a game, a soccer referee runs about 9-13 kilometers, which correspond to 85-90% of a maximum heart rate and 70-80% of a maximum oxygen uptake (VO₂ max), respectively (Catteral, Reilly, Atkinson & Coldwells, 1993) ^[1]. Approximately 4-18%, from the total distance that is covered during the game, is effort in high intensity.

In comparison to the players, the referees are on average 15-20 years older, and due to their physical condition, it is sometimes difficult to cope with the demands of the entire soccer game. Furthermore, this significant physical strain can affect the mental state and the concentration of a referee during the match ^[1]. In terms of maximal aerobic capacity the referees have high VO₂max values, which are lower compared to the respective values of the soccer players, with average values of 44-50 ml/kg/min (Bangsbo, 1994) ^[2]. FIFA and UEFA used other fitness tests (Leger & Boucher, 1980) ^[3], that were not as demanding as the modern fast pace soccer game though. FIFA and UEFA nowadays use special tests, such as the Yo-Yo Intermittent Recovery Test (YYIRT), which have been designed and approved for use on referees (Bangsbo, Iaia & Krustup, 2008) ^[4].

The aerobic fitness is positively correlated with the performance of the referee during a soccer game. The referees have to train in order to develop their aerobic capacity to cope with the physical demands of the game. The referees cover great distances during the games and repeat efforts with high intensity. Studies have shown improvements in the YYIRT performance with both a short term training program (12 weeks) and a long term one (16 months) with high intensity stimulus (Bangsbo, 1994) ^[5].

Castagna's *et al.* article (2007) ^[6], presents many studies which were conducted with elite level referees. Most of the research leads to the conclusion that a referee of a high level covers on average a distance between 9 and 13 kilometers during a soccer match.

In the Danish League One, according to the study conducted by Krustup and Bangsbo (2001) [7], the overall distance that the referees cover during a match was 10.07 kilometers on average and the average heart rate was 162 pulses per minute, 85% of their maximum heart rate.

Another study with referees and their assistants at the UEFA level, published in 2004 by Helsen and Bultynck [8] and conducted during the Euro 2000 has proven that the average heart rate of referees was 155 pulses per minute and 140 pulses per minute for the assistant referees. Additionally, the study by Reilly and Gregson (2006) [9], showed that a referee covers about 10 kilometers during each match, their heart rate is between 160 and 165 pulses per minute and the maximum oxygen uptake was at 80% of the maximum heart rate. The assistants, on the other hand, covered 7.5 kilometers in each game, with 140 pulses per minute on average, and the maximum oxygen uptake reached 65% of the maximum heart rate.

A study by Weston and Brewer (2002) [10], showed that the VO₂max of the high level referees reached 80.5-81% of the maximum heart rate. Harley, Tozer and Doust (2002) [11], stated that a decline of the VO₂max was observed during the second half of the game, from 81% to 79% of the maximum heart rate. In contrast, another study [7] did not reveal any differences in the VO₂max between both halves of the game. In recent years there is a great interest for studies in regards to soccer referees. The physiological aspect of the Greek elite -soccer referees such as VO₂max has not been studied so far, making the present study a novel and very important one for

the Greek reality of soccer refereeing. There is almost no research to assess the % BF which may also affect their performance. Nowadays, the game is faster than in the past and it is evident that a higher fitness level is needed to meet the demands of elite level refereeing. Hence, the control of body fat level in elite referees is important in order for them to achieve very high standards required when refereeing. Casajus and Castagna (2007) [12] reported an average BF of 11.3% and Casajus, Matute-Llorente, Herrero and González-Agüero (2016) [13] reported an average BF of 10.8%. Therefore, the aim of the present study was to examine the maximum oxygen uptake and the % BF of elite-level Greek soccer referees.

2. Statistical Analysis

The Statistical Package for the Social Science version 19.0 (SPSS in., Chicago, IL, USA) was used and the data are presented in arithmetic means and standard deviation.

3. Subjects

The referees who participated in the study were 16 men, 36.4 ±4.9 years old on average, the oldest being 42 years old and the youngest 25 years old (fig 1). Also one 35 year-old woman participated in the study (table 1). The referees were enrolled in the Referees Technical Committee (KEΔ-in Greek) of the Hellenic Soccer Federation (EPO). All referees were apparently healthy and had taken part in the physical supervised training program that implemented by KEΔ.

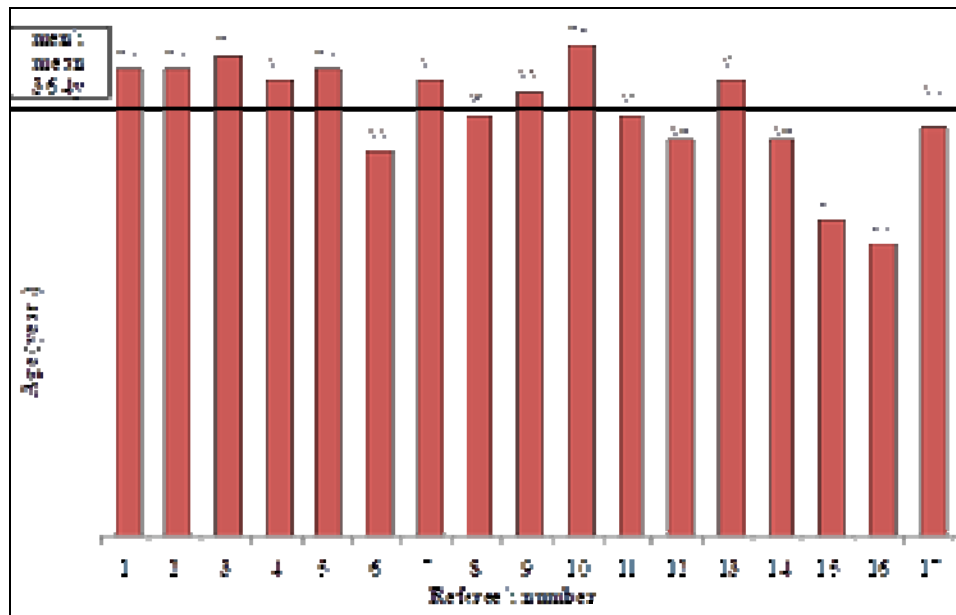


Fig 1: Age of referees, 1-16 (men) 17 (woman)

Table 1: Characteristics of subjects

Sex	N	Age (years)	
Men	16	Mean	36.4
		Std. Dev.	4.9
		Min	25
		Max	42
Woman	1	35	

4. Results

The variables of VO₂max and % BF of the referees are presented in Table 2 and Fig. 2-3. The results for the Super League referees and their VO₂max levels showed that the

average for the 16 male referees was 51.7±6.4 ml/kg/min and for the female it was 44.1 ml/kg/min. The average body fat of men was 15.3±2.8%, while for the female referee it was 16.3% (Table 2).

Table 2: Descriptive parameters

	Men (N = 16)	Woman (N = 1)
	Mean ± SD	Value
VO ₂ max (ml/kg/min)	51.7 ± 6.4	44.1
Body fat percentage (%)	15.3 ± 2.8	16.3

4.1 Referee's VO₂max

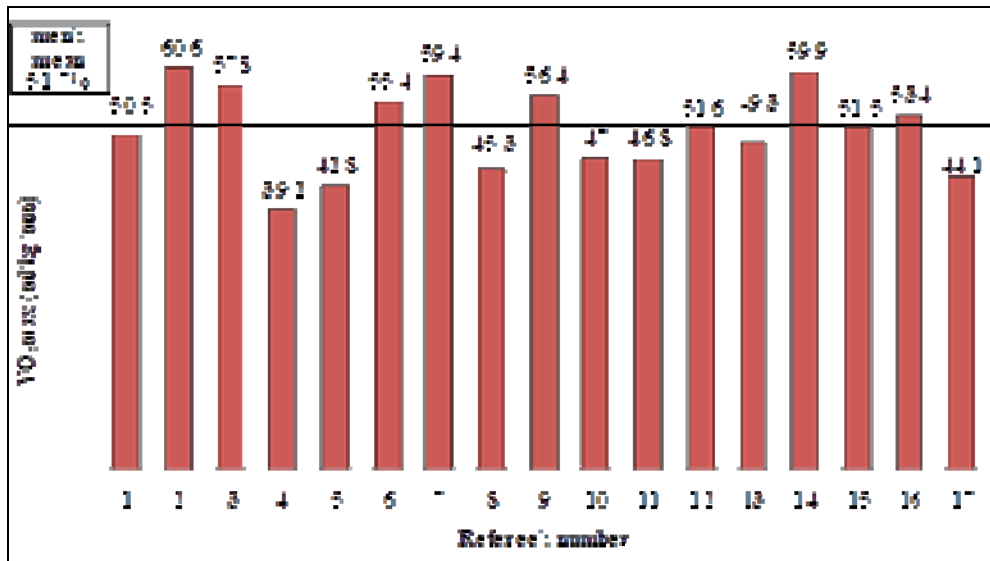


Fig 2: Referee's VO₂max, 1-16 (men) 17 (woman)

The maximum value for the male referees was 60.6 ml/kg/min and the minimum value was 39.2 ml/kg/min (Fig 2).

4.2 Referee's body fat

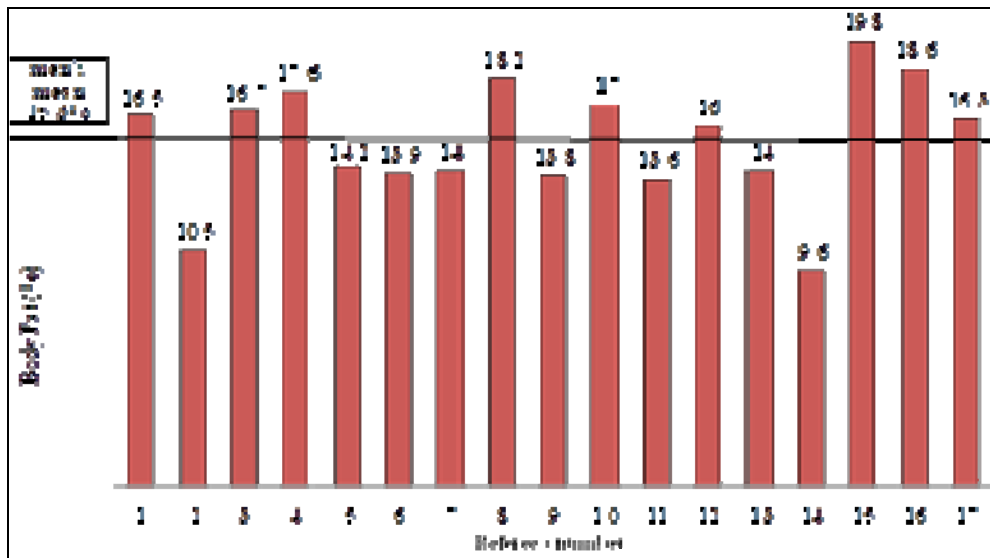


Fig 3: Referee's body fat, 1-16 (men) 17 (woman)

The maximum value for the male referees' body fat was 19.8% and the minimum was 9.6%, while for the female referee it was 16.3% (Fig 3).

The older referees had a lower % BF and higher values of VO₂max.

Referees, number 2 and 14 had the best scores in both variables of VO₂max (60.6, 59.9) and % BF (10.5, 9.6). The referees, number 7 and 9 had good levels of VO₂max (59.4, 56.4) and also good values of % BF (14, 13.8).

5. Discussion

As it is proven here, the value of the average VO₂max of Greek male referees was 51.7 ±6.4 ml/kg/min. In comparison to the study that was done by D' Ottavio and Castagna (2001) [14], the 8 high-level referees who participated had an average of 49.3±8.0 ml/kg/min. Also, in the study by Tessitore, Cortis,

Meeusen & Capranica (2007) [15], it was shown that the 10 referees with experience in local championships in Italy had an average VO₂max of 51.8±3.2 ml/kg/min. The average maximum oxygen uptake in the study by Weston *et al* (2011) [16] ranged at the similar levels, which was 52.3 ml/kg/min in 2002 and 50.8 ml/kg/min in 2010. Finally, Caballero *et al* (2011) [17], showed that the average VO₂max of 22 high-level Spanish referees was 48.7±4.3ml/kg/min.

One study that was conducted in Italy's League one [14], showed that referees reached 89% of their maximum heart rate. Eight high level referees, 37 years old on average, participated in 16 games over two soccer seasons. Maximum oxygen uptake tests were also conducted, of which the results showed that the VO₂max was about 49.3 ml/kg/min. The conclusion of this study was that the higher the maximum oxygen uptake is, the more active the referee is during the

game. Catterall *et al.* (1993) ^[11] used the same method during the League One championship in England and showed that the maximum heart rate count of the referees was about 95% of their maximum heart rate.

According to Weston *et al.* (2011) ^[16], the value of VO₂max remained consistent in a study that was concluded after an eight year long research, from 2002 to 2010, with 52.3 ml/kg/min in 2002 as opposed to 50.8ml/kg/min in 2010. Similar results in the VO₂max count of referees were observed in another study ^[17] with 22 high level Spanish referees, at an average of 26 years old. The test showed that the average maximum oxygen uptake of the referees was 48.7 ml/kg/min. Finally, in Tessitore's *et al.* study (2007) ^[15], 10 referees took part, at an average of 24 years old, having at least 3 years of experience in local championships in Italy. The results showed that their VO₂max was an average of 51.8 ml/kg/min and the maximum heart rate was 194 pulses per minute.

The main finding of this study is that Greek men referees have in general good values of VO₂max, with an average of 51.7ml/kg/min, compared to the above studies. The older referees have the highest values of maximal oxygen uptake and the younger ones some of the lowest (Fig 2). Not all referees had adequate and healthy levels of % BF, ranging from 9.6-19.8 (mean 15.3). The % BF of Greek referees is higher than the study ^[12] that found that Spanish soccer referees had 11.3% BF on average and higher than the 10.3% BF of elite football referees in Bosnia and Herzegovina (Talović *et al.*, 2018) ^[18], but lower than the studies of Inacio Da Silva *et al.* (2011 & 2014) ^[19] ^[20] that showed 19.3% BF and 15.5% BF on average in Brazilian referees. For the woman referee the value was 16.3% BF and that means that she has a good level of % BF according to the American Council on Exercise (ACE) that suggests that the body fat norms of athlete females are between 14-20% BF ^[21].

Results obtained by this research are not similar to previous studies conducted on European soccer referees in terms of age and body fat ^[12] that did not find age-related effects on VO₂max. This study showed that there was a tendency for the older referees to have higher values of VO₂max and a lower % BF. The unexpected result is that the highest values of % BF were observed in the younger referees. The two younger referees presented with a 19.8% BF and 27 years old and 18.6% BF and 25 years old (the only two both under 30 years old). An explanation may be the higher expertise and the training years of the older referees as well as their proper diet in order to cope with the demands of the game. There is a direct relation between VO₂max and % BF evident even in these younger subjects as well. A lower VO₂max would have been expected for these levels of % BF though. The results of the study are contradictory to previous research that has reported age-related decrements in VO₂max of 5 - 15% per decade after the age of 25 years-old ^[22].

So, considering that the elite-level Greek soccer referees are officiating at Super league, this group (especially the under 30 years of old) should be studied in more detail in future research projects.

6. Conclusion

After comparing the results of the maximum oxygen uptake of Greek male referees with the respective foreign male referees, it is observed that the average values do not differ much. Based on the studies that were conducted all these previous years and their results, the Greek referees are at a satisfying level, in regards to their aerobic fitness. It is

important that referees must train to improve aerobic ability in order to cover large distances and to repeat high intensity efforts during the game. Body fat average was acceptable, but not of a good level as in other elite level referees of other European countries. Not all Greek referees reported healthy values of % BF, which are directly related to high aerobic fitness standards, required when refereeing. Although the referees in Greece have a non-professional status, they have to train like a professional in order to progress and stay on advanced levels for longer periods. The referee cannot be substituted like players are during the game, so the demands on a referee regarding their physical fitness are great. It is therefore recommended that the referees with higher values of body fat start a guided nutritional and training program in order to reduce their % BF and potentially increase their values of VO₂max.

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