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ORIGINAL ARTICLE

Body fat in elite Spanish football referees and assistants: A 1-year follow-up study

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KEYWORDS
Adiposity;
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Abstract
Introduction: The current literature about the body composition of elite football referees is scarce and almost non-existent. Therefore, the aim of this study was to assess and track the percentage of body fat (%BF) of elite Spanish football referees and assistant referees across an entire season.
Material and methods: Two hundred and twenty-eight referees and assistant referees (mean age 32.5 ± 5.1 y), refereeing in Spanish First category (La Liga), Second category, and Second-B category, took part in this study. A bioelectrical impedance analyser (TANITA BC 418-MA) was used to evaluate %BF. A total of four-time-points for 1st category referees and three for all other groups were performed throughout the season.
Results: Analysing by category and role, 1st category assistants had the highest %BF in all assessments ($p < 0.05$). Small variations (around 1%) in %BF within groups were observed across the competitive season.
Conclusion: The %BF in elite Spanish referees remains constant, analysing by category, role and age, throughout a competitive season. All groups in this study reported healthy %BF values, between 8 and 14%, which might directly help to achieve the high standards required when refereeing and to improve the level of refereeing in the Spanish leagues.

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PALABRAS CLAVE
Adiposidad;
Grasa corporal;
Impedancia eléctrica;
Fútbol y arbitraje de fútbol

Grasa corporal en los árbitros y asistentes de fútbol de élite: estudio de seguimiento durante un año

Resumen
Introducción: La literatura actual relativa a la composición corporal de los árbitros de fútbol de élite es escasa y prácticamente inexistente. Por tanto, los objetivos de este estudio fueron evaluar y realizar un seguimiento del porcentaje de grasa corporal (%GC) a los árbitros de fútbol de élite españoles, y a los árbitros asistentes, a lo largo de toda la temporada.
Material y Métodos: En este estudio participaron doscientos veintiocho árbitros y árbitros asistentes (edad media $32{,}5 \pm 5{,}1$), que arbitran en la primera división de España (La Liga), la segunda división y la segunda división B. Se utilizó un analizador de impedancia bioeléctrica (TANITA BC 418-MA) para evaluar el porcentaje de grasa corporal. Durante la temporada se realizaron un total de cuatro mediciones en los árbitros de primera división, y tres para el resto de los grupos.
Resultados: Realizando un análisis por categoría y función, los asistentes de primera división tuvieron un mayor porcentaje de grasa corporal en todas las evaluaciones ($p < 0{,}05$). Se observaron pequeñas variaciones (de alrededor del 1%) en cuanto al porcentaje de GC dentro de los distintos grupos a lo largo de la temporada de competición.
Conclusión: El porcentaje de grasa corporal en los árbitros españoles de élite permanece constante, tras analizar la categoría, función y edad a lo largo de la temporada de competición. Todos los grupos incluidos en el estudio reportaron unos valores saludables en cuanto a grasa corporal, comprendidos entre el 8 y el 14%, lo que podría contribuir directamente al logro de los elevados estándares requeridos para el arbitraje, y a la mejora del nivel de arbitraje en las ligas españolas.

Introduction

Important research has been conducted regarding football referees since the first publication in 1994[1] until the last review published in 2012.[2] The physiological aspects of football refereeing such as maximal oxygen uptake or blood lactate levels in referees have been extensively reviewed.[3] In fact, a narrative review about Science and Medicine applied to football refereeing targeted these aspects.[2] However despite the crucial role of referees in a football match, almost no research has aimed to assess their body composition, which may affect their performance.

In this regard, an excess of body fat represents an inert load, associated with an increased metabolic cost and is also strongly associated with low fitness levels in adults.[4] Thus, evaluating body fat levels in elite referees is an important issue in order to achieve the high standards required when refereeing. Especially relevant in years when there is a World Cup or European Football Championship and the football calendar is shorter than other years.

To date, only one research article has been published focusing on body composition in football referees and it was showed that, in preseason, 1st and 2nd B category referees had lower total percentage of body fat (%BF) than 1st and 2nd category assistant referees (9.6 and 9.8% vs. 12.8 and 12.0%).[5] To our knowledge, no studies have assessed the %BF along an entire competitive season in a large sample of male elite football referees and assistants from different categories and age groups. Body composition is one of the most important factors that contribute to optimal exercise performance considering that it can affect athlete's strength, agility, and appearance.[6] For this reason, changes in body composition may affect the performance of referees. Nevertheless, assessing %BF evolution during the season may be easy, for example, bioelectrical impedance analysis (BIA) is a simple, fast and inexpensive method for assessing changes in body composition of large groups of people.[7]

Therefore, the aim of this study was to assess and to track changes in %BF of elite football referees and assistants during the 2012–2013 season officiating Spanish professional Tournaments. This knowledge will serve as reference for %BF across a season in football referees.

It is hypothesized that %BF in professional football referees and assistants will remain unchanged along the whole season.

Material and methods

This longitudinal study was performed in accordance with the Ethical Guidelines of the Helsinki Declaration of 1975 (revised in Fortaleza, 2013).

A total of 20 1st category, 22 2nd category, 120 2nd B category referees, and 40 1st category and 44 2nd category assistant referees participated in this study. All referees and assistants were Caucasian and apparently healthy. They had taken part in the supervised physical training programme that the Real Federación Española de Fútbol (RFEF, in Spanish) implemented.

Some of the participants were absent in some assessment for several reasons such as injuries or officiating international matches. A total of 152 referees (16 1st category referees, 21 2nd category referees and 115 2nd B category referees) and 76 assistants (34 1st category assistant referees and 42 2nd category assistant referees), were included in the statistical analysis. The assessments were performed along the season 2012–2013, as part of the assessment that the Referee Technical Committee (CTA, in Spanish) carried out on behalf of the RFEF. The same sports medicine doctor (expert Level 3 ISAK) performed the assessments in four-time-points of the season for 1st category referees and assistant referees: July 2012, November 2012, February 2013, and April 2013. The rest of referees and assistant referees (2nd and 2nd B categories) only participated in the first three assessments. These time-points are key moments for assessing and supervising health and body composition of referees and assistant referees along a competitive season. Following the established criterions by the Union of European Football Associations (UEFA) and the Fédération Internationale de Football Association (FIFA) organizations, the CTA evaluates the exercise performance of each referee and assistant referee conducting different tests and evaluating aerobic capacity, agility and speed. Those referees who did not reach the required minimum levels are not allowed to referee.

Participants' height was measured with a stadiometer without shoes and the minimum clothes to the nearest 0.1 cm (SECA 225, SECA, Hamburg, Germany). A portable BIA analyser TANITA BC 418-MA (Tanita Corp., Tokyo, Japan) with a 200 kg maximum capacity and 0.1 kg precision was used to measure weight and estimate %BF. Prior to the test, all participants were instructed to follow the BIA pre-testing guidelines (no alcohol or vigorous exercise less than 12 h and no food and drink less than 3 h prior to measurement, no excess food and drink on the day before measurement and urination immediately before measurement) and measurements were taken after the first micturition in the morning (between 8:00 and 9:00 a.m.). All measurements were taken by a sports medicine doctor. Participants were in underwear and BIA device provides measurements of impedance and estimates the %BF (precision 0.1%), fat and lean masses (precision 0.1 kg). The same standard conditions (room temperature, place, and device) were maintained for all participants in each measurement and at each time-point.

In order to test the age-related variations along a season in %BF, based on the classification proposed by Castagna[8] the sample was split into three age-group categories: younger than 33-year (youngest group), between 33 and 38 years (middle group) and older than 38 years (senior group).

Data are presented as mean and standard deviation, unless otherwise stated. The results of the Kolmogorov–Smirnov tests showed normal distribution in all the variables. One-way analysis of variance (ANOVA) tests with a Hochberg's GT2 post hoc test were used to determine differences between category and role and between age groups for %BF in the first assessment. ANOVA for repeated measures with Bonferroni post hoc tests were performed for %BF to evaluate the possible variations within the season in each group by category, role and by age group. Significance level was set at 5% ($p < 0.05$). The Statistical Package for the

Table 1 Anthropometric characteristics of entire group ($n = 228$); category groups and age related categories.

Variables	All ($n = 228$)	Category and role groups					Age groups		
		1st Referees ($n = 16$)	2nd Referees ($n = 21$)	1st Assistants ($n = 34$)	2nd Assistants ($n = 42$)	2nd B Referees ($n = 115$)	*Y* (<33 y) ($n = 130$)	*M* (33–39 y) ($n = 71$)	*S* (>39 y) ($n = 27$)
Age (y)	32.5 ± 5.1	38.2 ± 4.5	31.7[A] ± 4.0	37.2[B,C,D] ± 3.9	33.1[A,C] ± 5.4	30.2[A] ± 3.9	28.8 ± 2.7	35.9[Y,M] ± 1.7	41.5[Y,M] ± 1.9
Weight (kg)	72.7 ± 6.3	72.6 ± 4.2	74.5 ± 5.3	74.5 ± 6.9	72.3 ± 6.5	72.0 ± 6.4	72.1 ± 5.9	73.0 ± 6.9	74.9 ± 6.7
Height (cm)	178.9 ± 6.1	180.1 ± 3.3	182.1 ± 4.8	177.7 ± 6.7	177.6 ± 6.5	179.0 ± 6.2	179.6 ± 6.1	177.8 ± 6.2	178.6 ± 5.9
BMI (kg/m^2)	22.6 ± 1.4	22.3 ± 1.1	22.4 ± 1.3	23.5[A,B,C] ± 1.5	22.9 ± 1.6	22.4 ± 1.3	22.3 ± 1.3	23.0[Y] ± 1.4	23.4[Y] ± 1.6
Fat (%)	11.5 ± 2.9	9.9 ± 2.1	9.8 ± 3.1	13.4[A,B,C] ± 2.8	12.6[A,B,C] ± 2.8	11.0 ± 2.6	11.0 ± 2.8	11.9 ± 2.9	12.8[Y] ± 3.1

BMI, body mass index; Y, youngest group; M, middle group; S, senior group.
[A] Significantly different from 1st referees $p < 0.05$.
[B] Significantly different from 2nd referees $p < 0.05$.
[C] Significantly different from 2nd B referees $p < 0.05$.
[D] Significantly different from 2nd assistant referees $p < 0.05$.
[Y] Significantly different from youngest group $p < 0.05$.
[M] Significantly different from middle group $p < 0.05$.

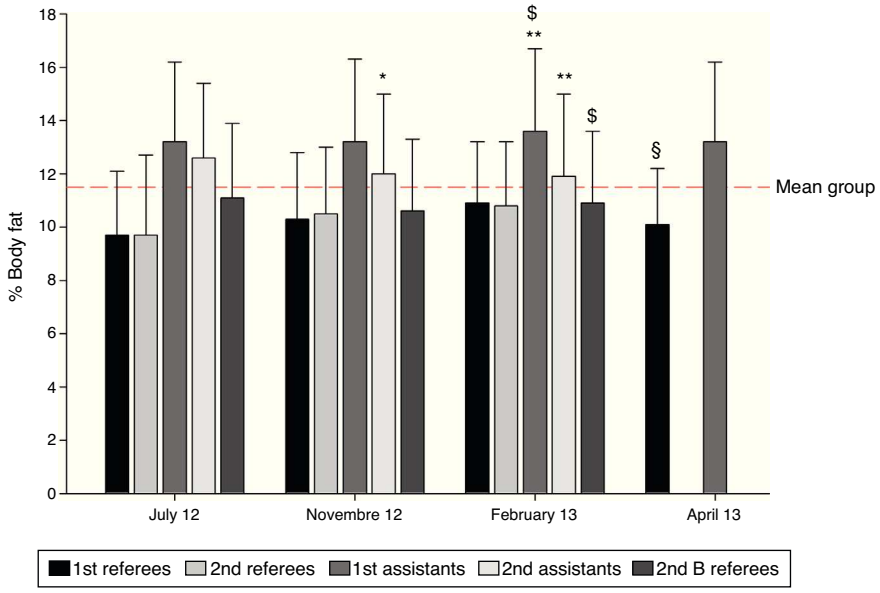

Figure 1 Total body fat throughout a season by category and role. *Differences between July 12 and November 12, $p < 0.05$; **differences between July 12 and February 13, $p < 0.05$; $differences between November 12 and February 13, $p < 0.05$; §differences between February 13 and April 13, $p < 0.05$.

Social Sciences (SPSS) version 19.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses.

Results

The descriptive characteristics of the sample divided by (1) category and role and (2) age-group are shown (Table 1).

By category and role, 1st division referees were the oldest (38.2 ± 4.5 y) and 2nd B division referees the youngest (30.2 ± 3.9 y) (all $p < 0.05$).

BMI was lower in 1st (22.3 ± 1.1%), 2nd (22.4 ± 1.3%) and 2nd B (22.9 ± 1.6%) division referees than 1st (23.5 ± 1.5%) division assistant referees (all $p < 0.05$). The %BF was lower in the 1st, 2nd, and 2nd B division referees than in the 1st and 2nd assistants (all $p < 0.05$).

By age group, lower BMI was observed in the youngest group (22.3 ± 1.3%) than the middle (23.0 ± 1.4%) and senior groups (23.4 ± 1.6%, both $p < 0.05$). Lower %BF (11.0 ± 2.8 vs. 12.8 ± 3.1%, $p < 0.05$) was found also in the youngest group than in the senior group.

The %BF throughout the season is presented by role and category (Fig. 1).

1st (9.9 ± 2.1%) 2nd (9.8 ± 3.1%) and 2nd B (11.0 ± 2.6%) referees had lower %BF than 1st (13.4 ± 2.8%) and 2nd (12.6 ± 2.8%) assistant referees in the first assessment (all $p < 0.05$).

A decrease in %BF was found between first and second assessment and between first and third in 2nd category assistant referees (0.6 and 0.7% respectively, both $p < 0.05$).

An increase in the %BF was found in 1st category assistant referees and 2nd B referees between second and third assessments (0.4 and 0.3% respectively, both $p < 0.05$).

A decrease in the %BF was found in 1st category referees between third and fourth assessments (0.8%, $p < 0.05$).

The %BF throughout the season is presented by age-group (Fig. 2).

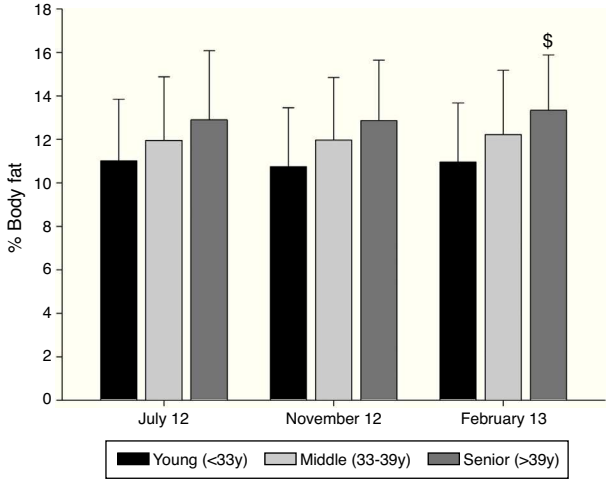

Figure 2 Total body fat by age-group. $Differences between November 12 and February 13, $p = 0.07$.

A trend for an increase in %BF was observed between second and third assessments in senior group (0.5%, $p = 0.07$).

Discussion

The main finding of the present study is that the %BF in elite football referees remains rather similar during a season, analysing by category, role and age. The tendency observed in this study was to get small increases in the %BF during the first three-time points. Except for 2nd category assistants who reduced their %BF during the whole season ($p < 0.05$). The 1st category assistant referees had higher %BF along the whole season compared to other groups among the roles and categories studied, nevertheless all groups reported healthy %BF values, above 8% and below 14%.

As expected, the youngest referees presented lower %BF than any others, and all age groups presented similar %BF at the three assessments; only the senior group showed a slight tendency towards an increase in %BF from November 2012 to February 2013.

This is a unique study that addresses a relatively unexplored area of elite football refereeing: body composition across a competitive season measured with BIA.

Refereeing is affected by the physical demands of elite football games.[2,3] In this regard, Weston et al.[9] reported a positive correlation between match activity of elite football players and referees. However, despite having similar physical demands than players, referees are, on average, 10–15 years older[10] and this is an important handicap to be taken into account. Therefore, elite referees have to possess a high level of physical fitness to officiate a match.

It is well known that contemporary match play is quicker than it was in the past[11] and higher fitness levels are required more than previously to meet the physical demands of elite refereeing. In fact, field testing has been incorporated as part of the referee match selection criteria by national and international refereeing governing bodies.[3]

Pietrobelli et al.[12] showed that there was a good correlation between whole-body %BF measured by 8-electrode BIA and dual energy X-ray absorptiometry ($r = 0.87$, $p < 0.001$). For this reason, BIA is a proper tool to be used when evaluating %BF in a large group of people.

To the best of our knowledge, just two previous studies analyzed body composition of elite football referees: Casajus and Castagna[13] who reported an average %BF of 11.3% using skinfolds according to Carter's equation;[14] and Casajus et al.[5] who reported an average %BF of 10.8% using BIA. Overall, in Casajus et al.[5] study referees in all categories (1st, 2nd and 2nd B) had lower %BF than assistant referees in both categories (1st and 2nd), as we observed herein. The %BF in the referees found in this study is similar to that reported on professional football players[15] but it must be taken into account that different assessment methods were used to evaluate them and that players and referees are in different age moments.

It has been shown that referees cover a mean distance of 11.6 km during a football match,[16] whilst assistant referees cover 6.5 km on average[17] and so it could be possible to think that assistant referees may not need such a high physical demands as referees does.

Improvements in body composition and physical fitness may help referees to promote into a higher category. However, it is surprising that the 1st category assistants had higher %BF compared with 2nd category assistants, the advanced age in the 1st division referees and assistants may be affecting this.

Another important point of this study is that almost all groups had their lowest %BF in the first assessment (preseason). The desire to be selected might perhaps lead to a higher level of training on the build-up to the first measurement period, as the selection occurs in August every year. It is important to notice as well that elite referees have two free-months during summer and it is supposed that they use this time to specifically train for the preseason assessment. However, during the season, different aspects such as the importance of the competition, trips, and in some cases the need to officiate two matches per week might directly influence their body composition. Nevertheless this did not happen in our study.

Changes in %BF of football players is a topic that has already been studied[15] but this is the first attempt carried out in elite football referees. While no changes in %BF was observed in a football season in elite young football players,[18] significant in-season variations were observed in professional football players (between start- and midseason and mid- and end-season).[15] In the present study, we must take into account the assessment method we are using and be very cautious with the interpretation of the obtained results. Although significant differences have been found between different time-points, the variability and systematic error of BIA is higher than those differences,[12,19] making these changes not relevant in a practical sense.

In the above mentioned study by Casajus and Castagna[13] no differences between age-group for %BF were found. However, in Casajus et al.[5] youngest group referees showed lower %BF than the middle and senior groups (10.2 vs. 11.4 and 12% respectively). In line with them, the youngest group in the present study showed lower %BF than middle and senior groups for most of the season. This fact might be, at least partially explained by the effect of ageing on body composition:[20] an increase in fat mass and a decrease in muscle mass[21,22] accompanies the process of ageing. On the other hand, experience is considered as a fundamental prerequisite to officiate matches at the elite level and the elite-level football referees usually reach their ''golden age'' career level around the age of 40.[23] As previously indicated, age influences body composition, therefore, changes in body composition need to be taken into account by the international refereeing governing bodies when performing physical fitness tests. Whether the ''golden age'' for refereeing regarding experience is 40 years, strategies should be implemented to ensure referees achieve that age with a fit body composition. FIFA fitness test[2] requires little specialized equipment and implementation, and can be performed worldwide, with protocols that enable a large number of referees and assistant referees to be tested simultaneously. As previously explained, BIA requires little time for completion without substantial investment, so it might be a useful follow-up-tool to include within the FIFA and UEFA fitness test and be used as another criteria for selecting future referees.

This study is not exempt of some limitations. Choosing a BIA equation that is not adapted to the populations studied continues to be a limiting factor of BIA. Another limitation is that the magnitude of the measurement errors involved in BIA measurements have previously been reported[19,24] to be typically greater than the body fat changes observed in this study. However, the inclusion of all referees and assistants that are officiating one of the most important leagues around the world accompanied by a reproducible and standardized design of evaluating are the main strengths of this study.

In conclusion, the results of this study showed that the %BF in elite football referees remains stable during a season analysing by category, role and age. All groups in this study reported healthy %BF values, between 8 and 14%, which might be directly related with the high fitness standards required when refereeing. Moreover, assistant referees and older referees presented higher values than principal

referees and youngest referees respectively across the whole competitive season. Monitoring changes in %BF in the highest level of football refereeing across a season might be an interesting issue to be addressed within the fitness test carried out by national and international refereeing governing bodies.

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