ORIGINAL ARTICLE

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

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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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Introducción

Importante investigación ha sido realizada desde la primera publicación en 1994 hasta la última review publicada en 2012.2 Los aspectos físicos del arbitraje de fútbol, como el consumo máximo de oxígeno o la lactato durante los partidos de la época, han sido extensamente revisados.3 En el ámbito del arbitraje de fútbol, se ha destacado la importancia de los árbitros y asistentes de fútbol que se relacionan con los cambios de la función corporal y la composición corporal.4 En este sentido, se ha realizado un análisis de los árbitros y asistentes de fútbol de élite y se han establecido estándares para el seguimiento.5

La Grasa Corporal en los Árbitros y Asistentes de Fútbol de Élite: estudio de seguimiento durante un año

En la introducción, se explica que la literatura ha sido escasa y prácticamente inexistente. Por ello, este estudio ha evaluado y realizado 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 veintiocho árbitros y árbitros asistentes (edad media 32,5 ± 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.

Conclusion: 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 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.

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

<table>
<thead>
<tr>
<th>Variables</th>
<th>All (n = 228)</th>
<th>Category and role groups</th>
<th>Age groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Referees (n = 16)</td>
<td>2nd Referees (n = 21)</td>
<td>1st Assistants (n = 34)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>32.5 ± 5.1</td>
<td>38.2 ± 4.5</td>
<td>37.2  ± 3.9</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72.7 ± 6.3</td>
<td>72.6 ± 4.2</td>
<td>74.5 ± 6.9</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>178.9 ± 6.1</td>
<td>180.1 ± 4.8</td>
<td>182.1 ± 6.7</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.6 ± 1.4</td>
<td>22.3 ± 1.3</td>
<td>23.5 ± 1.5</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>11.5 ± 2.9</td>
<td>9.9 ± 2.1</td>
<td>9.8 ± 3.1</td>
</tr>
</tbody>
</table>

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.
E Significantly different from youngest group p < 0.05.
F Significantly different from middle group p < 0.05.
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).

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.\(^1\)\(^2\) In this regard, Weston et al.\(^7\) 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\(^1\) 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;\(^1\)\(^7\) and Casajus et al.\(^3\) 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\(^11\) 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\(^11\) 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 \(\text{pre-season}\). 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 pre-season 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\(^13\) 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 \(\text{between start- and mid-season and mid- and end-season}\);\(^19\)\(^20\) 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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