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ORIGINAL

EFFECTS OF A COMPETITIVE PERIOD ON THE ANTHROPOMETRIC PROFILE OF SOCCER REFEREES

EFECTO DE UN PERIODO COMPETITIVO SOBRE EL PERFIL ANTROPOMÉTRICO DE ÁRBITROS DE FÚTBOL

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ABSTRACT

The aim of this study was to analyze the effect of a 10-week competitive period on body composition, anthropometric characteristics and somatotype in soccer referees. Fourteen officials (28.8 ± 5.1 yr) from different national soccer categories of Spain took part in the study. A decrease in the sum of eight skinfold thicknesses (Δ = -6.07%, $p < 0.05$, d = 0.38, low) was observed after the competitive period. Moreover, decreases in adipose mass (Δ= -2.29%, $p < 0.05$, d = 0.19, trivial) and endomorphic component were also observed. A 10-week competitive period has demonstrated to decrease both skinfold thicknesses and adipose mass, changing the somatotype of the referees.

KEY WORDS: referees; soccer; anthropometry; evolution; competition.

RESUMEN

El objetivo de este estudio fue analizar el efecto de un periodo competitivo de 10 semanas sobre las características antropométricas, la composición corporal y el somatotipo de árbitros de fútbol. 14 árbitros de fútbol (28,8 ± 5,1 años) de distintas categorías nacionales de fútbol de España participaron en este estudio. Se observó un descenso significativo tras este periodo competitivo en el sumatorio de ocho pliegues (Δ = -6,07%, $p < 0,05$, d = 0,38, bajo). Además, se observó un descenso significativo en el porcentaje de masa adiposa (Δ= -2,29%, $p < 0,05$, d = 0,19, trivial) y en el componente endomorfo (Δ= -6,82%, $p \leq 0,05$, d = 0,32, bajo) en el postest. Un periodo competitivo de 10 semanas parece ser suficiente como para provocar modificaciones en el somatotipo y un descenso del sumatorio de pliegues y de la masa adiposa en árbitros.

PALABRAS CLAVE: árbitros; fútbol; antropometría; evolución; competición.

INTRODUCTION

Almost 1 million soccer referees of different competitive levels are registered in a soccer federation and officiate at least once per week. Many studies on soccer referees have been conducted from different points of view in the last 20 years. Match-play activity profile (Krustrup & Bangsbo, 2001), results from physical fitness tests (Mallo, Navarro, Garcia-Aranda, & Helsen, 2009), training load quantification (Mallo et al., 2009) and type and number of injuries suffered by soccer referees have been previously reported (Gabrilo, Ostojic, Idrizovic, Novosel, & Sekulic, 2013). However, we have only found three studies assessing the anthropometric profile of soccer referees (Casajús, Matute-Llorente, Herrero, Vicente-Rodríguez, & González-Agüero, 2014; da Silva, 2011; da Silva, de los Santos, & Cabrera, 2012). Because referees officiate a high number of matches throughout the competitive season, maintaining optimal physical fitness is determined to some extent by the evolution of their anthropometric characteristics and the reduction of injury occurrence. It is therefore particularly important to assess the anthropometric profile of soccer referees.

While most studies have analyzed anthropometric characteristics of soccer referees such as height, mass and body mass index (BMI), only a limited number have reported their influence on performance. Moreover, little research has evaluated the association between anthropometric characteristics and physical fitness. Referees cover approximately 11-12 km per game, of which 1 km is covered at high speed (> 19.8 $km \cdot h^{-1}$) (Weston et al., 2012). Besides, the number of total sprints (speed > 25.2 $km \cdot h^{-1}$) is 21.3 ± 30.5 (Weston et al., 2012). In these previous studies, soccer referees performed 1,260 changes of direction per match and Mallo et al., (2009) reported that the 13% of total time was covered by sidewards and backwards running. Furthermore, referees must maintain an appropriate fitness level in order to pass the quarterly physical tests proposed by the National Soccer Referees Committee. Therefore, due to the high physical training and competitive demands, referees must develop healthy eating habits that will help them perform at their highest level (da Silva, 2011) and on the other hand, have appropriate anthropometric characteristics in order to keep up with play.

Nowadays, referees officiate almost during a whole year, being the end of the competitive period (April-June) the moment with the greatest social and economic impact, when promotions and relegations as well as when the final stages of national an international competitions are being held (Castillo, Yanci, Casajús, & Cámara, 2016; Magaz-González, Mallo-Fernández, & Fanjul-Suarez, 2015). Because of the importance of the end of the competitive period, officials must perform at a very high level during this stage. No previous research has characterized the anthropometric profile of referees at the end of the competitive season in spite of studies analyzing their anthropometric profile (da Silva et al., 2012; Gabrilo et al., 2013) and its association with physical demands (Fernandez, da Silva, & Arruda, 2008; Mazaheri, Halabchi, Barghi, & Mansournia, 2016). Because of the duration of the competitive period, it would

be interesting to determine the evolution of the anthropometric profile and body composition of referees throughout the competitive period and especially, during its final stage. In spite of previous research characterizing the anthropometric profile of soccer referees at particular times during the season, we have not found any study describing the evolution of their anthropometric characteristics at particular times during the competitive period.

Therefore, the aim of the present study is to analyze the effect of a 10-week competitive period at the end of the season on anthropometric characteristics, body composition and somatotype in high level soccer referees.

MATERIAL AND METHODS

Participants

14 high level soccer referees (28.8 ± 5.1 yr) from different national soccer categories (1st, 2nd division A and 2nd division B) of Spain took part in this study. They were selected using a non probabilistic sample of convenience. All of the participants had at least 10 years of refereeing experience and officiated 3-4 official matches per week during the competitive period. All of them trained 3-4 times per week and no one was injured during the investigation period. The subjects voluntarily participated in the study and were informed of the research purpose after signing the informed consent. The study was conducted in compliance with the Declaration of Helsinki (2013) and the Law on Personal Data Protection (LOPD). Approval by the institutional review board from the University of the Basque Country (UPV/EHU) was obtained before the study began.

Experimental design

This study took place during the competitive period, between April and June. Anthropometric parameters where measured (pre: before the 10-week competitive period; post: after the competitive period) by a certified anthropometrist, according to the International Society for the Advancement of Kinanthropometry (ISAK) (ISAK, 2011). Participants were instructed not to eat a heavy meal or perform any exhaustive exercise 48 h prior to testing.

Anthropometric assessment, body composition and somatotype. Height (cm), body mass (kg), skinfolds thicknesses, width and girth data were collected from each participant. Height and body mass were measured using a stadiometer and balance (Seca, Bonn, Germany), respectively. Body mass index (BMI) was calculated from body mass and height measures ($kg \cdot m^{-2}$). Eight skinfold thickness (bicipital, tricipital, subscapular, abdominal, suprailiac, supraspinal, thigh and calf medial skinfolds) (Holtain, Crymych, United Kingdom) measurements were used to calculate the sum of 6 and 8 skinfolds. Additionally, 5 body girths (arm-relaxed, waist, hip, mid thigh and calf) were measured with a non-flexible anthropometric tape measure (Holtain 110P-

98606, United Kingdom) from which waist and hip girths were used to calculate the waist-hip ratio (waist girth (cm) / hip girth (cm)). Flexed arm girth was used to determine somatotype. Humerus and femur widths (cm) were measured with a caliper (HLT-100, Holtain Ltd., United Kingdom). Body composition was calculated using the Ross and Kerr (1991) equation for adipose mass, and the equation (body mass - adipose mass) was used to obtain lean mass, in both absolute (kg) and relative (%) terms. Somatotype was calculated by the mean somatotype and the three components of somatotype (endomorphy, mesomorphy and ectomorphy) by using the Heath-Carter somatochart.

Physical activity quantification during the competitive period. Referees officiated during the last 10 weeks of the season whilst completing their habitual training guided by the physical trainer of the Referee Committee. Borg's Category Ratio-10 (CR-10) Rating of Perceived Exertion (RPE) was collected 10 min after each exercise session to calculate training load (RPE-TL) (i.e., training and match-play). Referees were familiarized with the 0-10 point scale during training and match-play sessions 2 months prior to data collection. TL was calculated by multiplying the training and match-play duration with the RPE score, as previously proposed by Foster et al. (2001).

Mean weekly training and match load data are shown as means ± standard deviation in Figure 1.

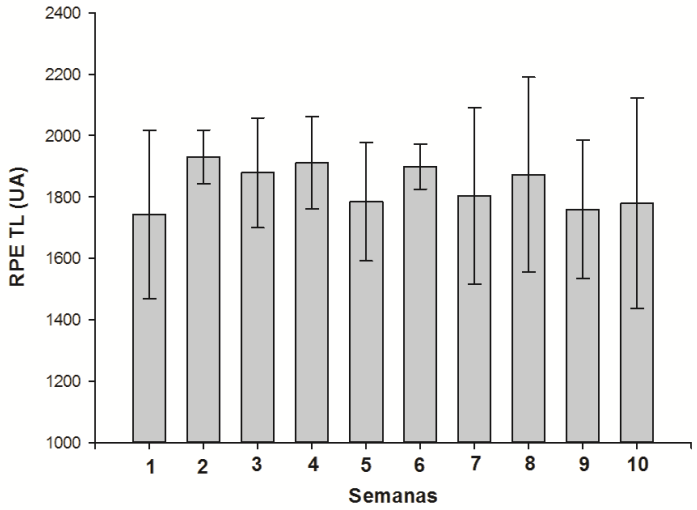

Figure 1. RPE-TL values during the 10-week competitive period.

Statistical analysis

Results are presented as means ± standard deviation. All the variables were normally distributed and satisfied equality of variances criteria according to the Shapiro- Wilk and Levene tests respectively. Student's t test for paired data was used to compare anthropometric and somatotype characteristics of soccer referees between pre- and post-tests. The percentage of the difference between pre- and post-test was calculated using the formula Δ (%) = [(post-test - pre-test) / pre-test] x 100. Effect size was assessed by calculating Cohen's d effect

size (Cohen, 1988). Effect sizes (ES) lower than 0.2, between 0.2 and 0.5, between 0.5 and 0.8 and above 0.8 were considered as trivial, small, moderate and large, respectively. Data analysis was performed using the Statistical Package for Social Sciences (version 23.0 for Windows, SPSS Inc, Chicago, IL, USA). Statistical significance was set at $p \leq 0.05$.

RESULTADOS

Sum of skinfolds and anthropometric variables (mean ± standard deviation) at pre- and post-tests are shown in Table 1. A significant decrease in supraspinal (Δ = -29.47%, $p < 0.01$, d = 1.12, high), suprailiac (Δ = -10.13%, $p > 0.05$, d = 0.50, moderate) and six (Δ = -6.18%, $p < 0,05$, d = 0.37, low) and eight (Δ = -6,07%, $p < 0,05$, d = 0,38, low) sum of skinfolds were observed. The other anthropometric parameters showed trivial and non-significant changes.

Table 1. Means ± standard deviations of anthropometric parameters, skinfold thicknesses, width and girth data of soccer referees at pre- and post-tests.

	Pre-test	Post-test	Mean differences (%)	p	d
Anthropometry					
Mass (kg)	73.1 ± 6.5	73.3 ± 6.9	0.27	NS	-0.03
Height (cm)	179.0 ± 7.0	-	-	-	-
BMI (kg·m^{-2})	22.8 ± 1.4	22.8 ± 1.5	-0.02	NS	0.00
Skinfolds (mm)					
Bicipital	3.6 ± 0.6	3.6 ± 0.4	1.16	NS	-0.07
Tricipital	7.7 ± 2.5	7.2 ± 1.9	-6.07	NS	0.18
Subscapular	8.2 ± 1.1	8.0 ± 0.9	-2.53	NS	0.19
Abdominal	9.9 ± 2.7	10.4 ± 2.4	4.55	NS	-0.16
Suprailiac	5.0 ± 1.0	4.5 ± 0.8	-10.13	NS	0.50
Supraspinal	9.1 ± 2.4	6.4 ± 1.4**	-29.47	0.00	1.12
Thigh	9.0 ± 2.2	9.1 ± 2.3	0.65	NS	-0.03
Calf medial	5.7 ± 1.3	5.5 ± 1.1	-4.10	NS	0.18
∑ of 6 skinfolds	49.6 ± 8.3	46.5 ± 6.3*	-6.18	0.01	0.37
∑ of 8 skinfolds	58.2 ± 9.3	54.7 ± 6.7*	-6.07	0.02	0.38
Girths (cm)					
Arm relaxed	28.1 ± 2.2	28.4 ± 1.8	1.04	NS	-0.13
Mid thigh	54.6 ± 2.9	53.4 ± 2.7	-2.21	NS	0.41
Waist	75.8 ± 3.9	76.6 ± 3.9	1.06	NS	-0.21
Hip	81.9 ± 3.8	82.1 ± 3.5	0.16	NS	-0.04
Calf	37.5 ± 2.6	37.1 ± 2.9	-0.93	NS	0.13
Biepicondyle diameters (cm)					
Humerus	7.2 ± 0.5	-	-	-	-
Femur	10.1 ± 0.7	-	-	-	-

BMI: body mass index; * $p < 0.05$; **; $p < 0.01$; d: effect size; NS: non significant.

Waist-hip ratio, body composition and somatotype data at pre- and post-tests are shown in Table 2. Adipose mass percentage decreased (Δ = -2.29%, $p < 0.05$, d = 0.19 trivial) and lean mass percentage increased after a 10-week competitive period. On the contrary, non-significant and trivial changes were observed in lean mass, in both absolute (kg) and relative (%) terms. Endomorphic component was significantly reduced at post-test (Δ = -6.82%, $p < 0.05$, d = 0.32, low) whilst mesomorphic component was increased (Δ = 16.30%, $p < 0.05$, d = -0.74, moderately).

Table 2. Waist-hip ratio, body composition and somatotype data of soccer referees at pre- and post-tests

	Pre-test	Post-test	Mean differences (%)	p	d
Ratio					
Waist-hip	0.93 ± 0.04	0.93 ± 0.03	0.90	NS	-0.22
Body Composition					
Adipose mass (kg)	18.32 ± 3.01	17.94 ± 2.89	-2.07	NS	0.13
Adipose mass (%)	25.00 ± 3.00	24.43 ± 2.94*	-2.29	0.02	0.19
Lean mass (kg)	54.79 ± 4.93	55.37 ± 5.31	1.06	NS	-0.13
Lean mass (%)	75.00 ± 3.00	75.57 ± 2.94*	0.77	0.02	-0.19
Somatotype					
Endomorph	2.0 ± 0.4	1.9 ± 0.3*	-6.8	0.05	0.32
Mesomorph	5.0 ± 1.1	5.8 ± 1.1*	16.3	0.03	-0.74
Ectomorph	2.8 ± 0.2	2.8 ± 0.8	0.6	NS	-0.02

d: effect size; NS: non significant; * $p < 0.05$

DISCUSSION

The aim of this study was to analyze the effect of a 10-week competitive period on anthropometric characteristics, body composition and somatotype in high level soccer referees. Even though having an appropriate anthropometric profile in order to keep up with play could positively affect both the refereeing activity and the results obtained in physical tests organized by the National Committee of Soccer Referees, only one study (Casajús et al., 2016) has addressed the anthropometric profile of soccer referees at particular times during the competitive season. The results of this study have shown a decrease in the sum of 6 and 8 skinfold thicknesses, mainly due to the decrease in supraspinal and suprailiac skinfold thicknesses after a 10-week competitive period. Adipose mass was also significantly reduced. On the other hand, the endomorphic component was reduced and the mesomorphic was increased.

Adipose mass has been, during the last years, one of the most studied parameters of body composition in athletes (Casajús, & González-Aguero, 2015; Casajús, Matute-Llorente, Herrero, Vicente-Rodríguez, & González-Agüero, 2016; Vaquero-Cristobal, Alacid, Esparza-Ros, Muyor, & López-

Minarro, 2015). Previous studies have reported that increases in adipose mass may be detrimental for performance (Reilly et al., 2000) and raise the risk of injury (Kemper et al., 2015). Even though BMI, body mass, skinfolds, width and girth data remained constant after 10 weeks of competition, the sum of 6 and 8 skinfold thicknesses decreased, mainly due to the decrease in supraspinal (29.47%) and suprailiac skinfold (10.13%) thicknesses. These results suggest that after a 10-week competition period skinfold thicknesses did not change similarly, because while some skinfold thicknesses decreased others remained unchanged. These results are consistent with those of others (Martin et al., 1985), who concluded that adipose tissue is not evenly distributed throughout the body. Even though we did not intend to analyze the adipose tissue distribution throughout the body, because supraspinal and suprailiac skinfold thicknesses decreased more than 10%, it would be interesting to analyze the evolution of other skinfolds thicknesses. Adipose mass thickness decreased significantly (2.29%) and lean mass showed trivial changes after a 10-week period. These results are consistent with a previous study (Casajús, 2001) showing decreased percent body fat in professional soccer players from the first division of the Spanish League. Likewise, previous research (Caldwell and Peters, 2009) has reported decreased body fat percentage after the competitive period and increased body fat percentage after the off-season period in semiprofessional soccer players from the English Nationwide Conference North League. However, body fat percentage remained unchanged throughout the competitive season in elite young soccer players (Hammami et al., 2013) and in National Collegiate Athletic Association (NCAA) Division III soccer players. Because this is the first study to report changes in anthropometric characteristics in soccer referees at particular times during the competitive period, more studies are warranted to further evaluate the effect of the competitive period on the anthropometric profile of soccer referees.

Declines in adipose mass, as observed in this study, might help increase physical performance at the end of the competitive period. Possibly, the decreases in the sum of eight skinfold thicknesses and percentage of adipose mass are related to the high physical load during training and matches. Refereeing is a physically high demanding activity, because total distance covered during a match-play is approximately 10 km, of which 34% are high-intensity activities (>13 km/h) (Mallo et al., 2009). Besides, at the end of the competitive season, when soccer teams are being promoted or relegated to other divisions and the National Committee of Soccer Referees promote soccer referees, it is paramount for referees themselves to use a range of nutritional strategies and peaking for optimal performance, possibly changing their body composition.

Somatotype analysis is a method for estimating body type and composition (Carter & Heath, 1990). Therefore it is used to characterize elite athletes and to identify sport talents, providing relevant information to physical activity and sports specialists (Fidelix et al., 2014; Orhan, Sagir, & Zorba, 2013). High level soccer referees participating in this study were mesomorphic at the end of the competitive season. In this regard, chilean first division referees, assistant

referees of Brazilian and Parana Confederation and Brazilian and Uruguayan first division referees were classified as mesomorphic-endomorphic (3,8-5,7-1,6; 3,5-4,4-1,9; 3,6-3,7-2,5 and 3,7-4,0-2,0, respectively) (Fernandez et al., 2008; da Silva, 2011; da Silva et al., 2012). Because there are not studies describing the evolution of somatotype in high level soccer referees during the competitive period, the results of this study add to literature by providing normative data for this population. In our study, endomorphic somatotype decreased and mesomorphic somatotype significantly increased after 10 weeks of training and competition. These results suggest that the physical exercise performed at the end of the competitive season may change the somatotype of soccer referees. It may also influence the sum of eight skinfold thicknesses and adipose mass percentage. However, no previous studies have analyzed differences in somatotype at other times of the season and therefore, further studies are warranted to determine the evolution of somatotype throughout the entire season.

The present study is not without limitations. Most notably, we did not control the food intake of the referees during the study. Food intake was maintained as usual. Since food intake may have affected the results of the present study, further investigations should control for it whilst studying the evolution of body composition.

CONCLUSIONS

Physical activity performed during the last 10 weeks of the competitive season has provoked a decrease in the sum of 6 and 8 skinfold, mainly due to a decrease in both suprailiac and supraspinal skinfold thicknesses and adipose mass. Endomorphic somatotype decreased and mesomorphic somatotype increased. Training and match-play demands may have been responsible for the somatotype changes. Further investigations should examine the anthropometric profile of soccer referees throughout the season.

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