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Nutritional and Body Composition Assessment in Costa Rican College Soccer Players aged 18 to 21 years old

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Abstract

Objective: To determine macronutrient consumption and body composition in male and female soccer players. Design: Cross-sectional descriptive study. Method: Participants were 22 male (mean age = 21.4 ± 1.9 yr.) and 19 female (mean age = 20.1 ± 1.7 yr.) players who were interviewed for dietary habits using a 7-day diet history questionnaire. Body composition was obtained by dual-energy X-ray absorptiometry (DXA). Total energy and macronutrient analysis was performed following the nutritional interview, and body height, weight, lean mass, fat mass (%), and intermuscular adipose tissue-free skeletal muscle mass (IMAT-SMM) were obtained from the DXA scan. Gender differences were obtained by independent samples t-tests. Results: Energy intake was higher in males (19377 ± 5514 kJ) than in females (13066 ± 4610 kJ; $p \leq 0.001$). Carbohydrate intake was higher in males (10.3 ± 3.2 g/kg) than in females (7.9 ± 3.8 g/kg; $p = 0.010$). Protein intake was higher in males (2.2 ± 0.8 g/kg) than in females (1.6 ± 0.5; $p = 0.031$). Fat consumption was similar between males (1.9 ± 0.8 g/kg) and females (1.7 ± 0.6 g/kg; $p = 0.117$). Body height (176.0 ± 6.1 cm vs. 160.4 ± 3.4 cm), weight (69.3 ± 7.7 kg vs. 59.2 ± 6.5 kg), lean mass (26.0 ± 2.0 kg vs. 16.9 ± 1.4 kg), and IMAT-SMM (31.0 ± 2.3 kg vs. 20.2 ± 1.6 kg) mean values were higher in males than in females ($p \leq 0.001$ for all). Fat mass was higher in females (31.4 ± 6.4 %) than in males (14.8 ± 5.2 %; $p \leq 0.001$). Conclusions: Excessive energy and carbohydrate intake was found in both genders. Protein and fat intake were appropriate for both genders. Body composition in males was similar to previously reported literature; however, females showed poor body composition compared to international values.

Key words: Soccer, Energy Intake, Body Composition, DXA, Dietary Analysis.

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Introduction

Football (soccer) is probably the most popular sport in the world. In several countries, including Costa Rica, participation in minor leagues has increased; which means a challenge to parents, coaches and athletes regarding knowledge on training and recovery practices, including nutrition (Umaña, 2005). This game requires a high-energy expenditure, mainly due to the long distances run and explosive efforts during training and competition (Gonzáles, Cobos, & Molina, 2010). During a game, the estimated energy cost for a man is ~1500 kcal and for a woman is ~1000 kcal; therefore, players should consume a variety of foods, mainly carbohydrates (CHO) (Gonzáles et al., 2010).

In football, body mass can influence the athlete's speed, strength and power, while body composition might affect strength and agility. A successful participation in this sport, in addition to a high level of technical and tactical skills, requires of each athlete adequate of anthropometric and body composition characteristics (Fernández, Kazarez, Agazzi, & Albín, 2014; Fragoso & Massuça, 2011).

Although there is research on body composition in football players, this evidence describes mostly American and European players (Popovic, Akpinar, Jaksic, Matic, & Bjelica, 2013; Tunar, Çetinkaya, Gümüş, Gençoğlu, Ünal, & Kayatekin, 2017), including soft tissue characteristics (Kafkas, Kızılay, Şahin Kafkas, Kızılay, Durmuş, & Pulur, 2018). In Central America, there are only a few studies in young Costa Rican players (Serrano Sanabria, Mora Poveda, Sánchez Ureña, Gutiérrez Vargas, & Méndez Solano, 2017). The evidence on body composition is usually gathered using the International Society for the Advancement of Kinanthropometry (ISAK) protocol, which is based on skinfolds measurements. However, the method might show a high error; therefore, a preferred and more valid and reliable assessment is the double energy X-ray absorptiometry (DXA). This method assesses percentage of body fat and other variables that are unfrequently studied, such as intermuscular adipose tissue-free skeletal muscle mass (IMAT-SMM) and lean tissue in body segments (legs and arms), this providing more accurate information.

In this context, the purpose of the study was to describe and compare nutrient and body composition of young Costa Rican football players. The hypothesis of the study was that the diet and body composition of male and female soccer players from 18 to 21 years was inadequate, according to individual requirements and established guidelines for football players described in the literature.

Methods

Design and participants

This is a descriptive and cross-sectional study where food components and body composition of a population of young soccer players were analyzed. The Scientific Ethics Committee of the University of Costa Rica approved the protocol and the participants read and signed the informed consent to participate in the study.

Volunteers were male (n = 22) and female (n = 19) varsity soccer players from a large public university in Costa Rica, Central America. These players were recruited from the Sports Department after clearing from the Sports Director and soccer coaches.

Procedures

Food composition: Participants were given individual appointments to the Human Movement Sciences Research Center (CIMOHU) at the University of Costa Rica, to complete a "dietary history questionnaire" (Chinnock, 2007). Participant also filled demographic information, an instrument about eating habits, an instrument to assess foods, beverages and supplements consumed during all meal times for seven days. During this evaluation, participants were asked to describe the foods, beverages and supplements, if consumed, ingested during the last seven days; this for each mealtime and orderly asking one by one (breakfast, lunch, dinner and snacks). Immediately, players were asked about common foods and beverages not mentioned during the interview; this for each mealtime again, in order to evaluate if these foods and beverages were consumed or not.

The food, beverage and supplement frequency consumption record, quantity and preparation mode of those foods and drinks of common consumption were also recorded. To avoid the omission of common foods and beverages, four sets of cards were delivered to the interviewee, which included fruits, snacks, sweets, salty snacks and drinks of common consumption in the country. Following food data collection, the estimated food amounts were converted to weight in grams and volume in milliliters (individual foods and recipe analysis), using a Camry® balance model EK5055 (Camry Scale-USA, City Industry, CA), and the Photographic Manual of Portions of Common Foods in Costa Rica authored by the University of Costa Rica School of Human Nutrition. The dependent variables collected using the instrument described above were mean daily energy intake (kcal/d) and macronutrients (mean consumption in g, g/kg body weight (BW), and total energy value (TEV%) for CHO, proteins and fat.

***Body composition*:** On the day of the application of the dietary history questionnaire, participants were given individual appointments to Human Movement Sciences Research

Center for body composition assessment. An electronic scale (e-Accura®, model dsb921) was used to measure body weight (kg) and a stadiometer (Novel Products, model DES 290237) to measure body height (cm). Then, a full-body DXA scan (General Electric, Lunar Prodigy Advance®, with software enCORE 2011, version 13, 60, 033) was performed following best practice guidelines described by Nana (2013). The dependent variables from DXA used for analyses were body fat mass (BF%), lean mass (%), arm and leg lean mass (kg), total lean mass (kg), and IMAT-SMM (kg).

Statistical analysis

Statistical analysis was performed with the IBM-SPSS Statistics, version 22 (IBM Corporation, Armonk, New York). The descriptive statistics are presented as the mean and the standard deviation (M ± SD). Non-parametric Chi2 tests were used to detect associations between dietary and body composition data. Independent samples t-tests were performed on diet and body composition variables. Statistical significance was established *a priori* at $p \leq 0.05$.

Results

Summary descriptive and inferential statistics for food and body composition variables are presented in tables 1 and 2. The 89.5% women and 18.2% men had an excessive BF%, for a total of 21 participants (51.2%) with nutritional status of excess adiposity. No significant association between adiposity and CHO intake ($\chi^2 = 0.93$, $p = 0.335$) or protein ($\chi^2 = 1.45$, $p = 0.228$) were found for all participants; however, a statistically significant association was observed between adiposity and fat intake ($\chi^2 = 5.63$, $p = 0.018$). The analysis by gender indicated that in both, men and women, there was no association between adiposity and the intake of any macronutrient.

Significant mean differences were found between men and women in all the variables studied ($p < 0.05$, for all), with the exception of TEV% for proteins, CHO and fats, as well as for fat g/kg BW. Total energy, CHO, and protein intake expressed in absolute (i.e., kJ, g) and relative (i.e., kcal or g/kg BW) units were higher in males than in females ($p < 0.05$, for all). Fat intake in g was higher in males than in females ($p = 0.027$) and similar between genders when expressed in g/kg BW ($p = 0.270$) (Table 1).

Table 1. Descriptive and inferential statistics for food composition variables of female and male football players.

	Females (n = 19)	Males (n = 22)	
Variable	**M ± SD**	**M ± SD**	**p ≤**
Energy			
Kcal	3123 ± 1102	4631 ± 1318	0.001
kJ	13066 ± 4610	19377 ± 5514	0.001
kcal/kg	53.3 ± 19.0	67.7 ± 20.8	0.027
Macronutrients			
Protein (g)	96.5 ± 32.3	149.8 ± 51.0	0.001
Carbohydrate (g)	460.2 ± 214.1	706.5 ± 206.8	0.001
Fat (g)	98.6 ± 35.8	132.4 ± 53.5	0.025
Macronutrients			
Protein (g/kg)	1.6 ± 0.5	2.2 ± 0.8	0.010
Carbohydrate (g/kg)	7.9 ± 3.8	10.3 ± 3.2	0.031
Fat (g/kg)	1.7 ± 0.6	1.9 ± 0.8	0.270
Total energy value (TEV%)			
Protein (%)	12.9 ± 3.8	13.0 ± 2.8	0.960
Carbohydrate (%)	57.6 ± 10.9	61.1 ± 7.4	0.228
Fat (%)	29.1 ± 8.3	25.8 ± 5.0	0.117

Body height, weight, BF%, arm lean mass, leg lean mass, total lean mass, and IMAT-SMM were higher in males than in females ($p \leq 0.001$ for all) (Table 2).

Table 2. Descriptive and inferential statistics of the anthropometric and body composition variables of female and male football players.

	Females (n = 19)	Males (n = 22)	
Variable	**M ± SD**	**M ± SD**	**p ≤**
Age (yr.)	20.1 ± 1.7	21.4 ± 1.9	0.023
Height (cm)	160.4 ± 3.4	176.0 ± 6.1	0.001
Weight (kg)	59.2 ± 6.5	69.3 ± 7.7	0.001
Body fat mass (%)	31.4 ± 6.4	14.8 ± 5.2	0.001
Arm lean mass (kg)	3.9 ± 0.6	6.8 ± 0.6	0.001
Leg lean mass (kg)	13.1 ± 1.0	19.3 ± 1.6	0.001
Body lean mass (kg)	16.9 ± 1.4	26.0 ± 2.0	0.001
IMAT-SMM (kg)	20.2 ± 1.6	31.0 ± 2.3	0.001

Note: IMAT-SMM = intermuscular adipose tissue-free skeletal muscle mass (kg)

Discussion

The purpose of the study was to evaluate the diet and body composition of young male and female football players. The ideal energy intake estimation was between 1198 to 1501 kcal (5012 to 6280 kJ) for women and 1623 to 2088 kcal (6790 to 8736 kJ) for men. The low mean lean mass (kg) used to estimate ideal energy intakes caused these low values. Previous studies

in young female soccer players reported a consumption between 1904 to 2291 kcal (7966 to 13075 kJ), and for male players from 2560 to 3478 kcal (11046 to 12678 kJ), suggesting that participants had excessive energy consumption, with a mean consumption for women of 3123 kcal (13067 kJ) and for men of 4631 kcal (19376 kJ).

The mean CHO consumption of women met the recommendation of 55% -70% TEV and differs from that found in other studies in female football players, where insufficient intakes were observed (Clark, Reed, Crouse, & Armstrong, 2003; Scott, Chisnall, & Todd, 2001). However, when expressed in terms of g/kg BW, the mean consumption of Costa Ricans is higher than recommended (5 to 7 g/kg BW/day), as well as that reported in other studies, where observed ranges are between 4.1 to 4.3 g/kg BW (Clark et al., 2003; Martin, Lambeth, & Scott, 2006). The mean CHO consumption of the male participants conforms with the TEV% recommendation and differs from other studies in which insufficient intakes were reported (Leblanc, Gall, Grandjean, & Verger, 2002; Ruiz et al., 2005). Male football players consider very difficult to consume a high CHO diet (Ono, Kennedy, Reeves, & Cronin, 2012; Russell & Pennock, 2011). Similar to women, the relative CHO ingestion is above the recommended intake of less than 6 g/kg BW (Bettonviel, Brinkmans, Russcher, Wardenaar, & Witard, 2016; Caccialanza, Cameletti, & Cavallaro, 2007; Garrido, Webster, & Chamorro, 2007; Hidalgo Terán Elizondo et al., 2015; Iglesias-Gutierrez et al., 2012; Ruiz et al., 2005; Russell & Pennock, 2011). In summary, men and women showed an excessive CHO intake. Based on a qualitative analysis, we identified that the high CHO intake came from refined food sources (e.g., sweet and salty pastries, filled cookies, chocolate bars, soft drinks and soda).

In football, a high CHO diet is essential for adequate performance (Garcia-Roves, Garcia-Zapico, Patterson, & Iglesias-Gutierrez, 2014). However, excess calories from glucose result in lipogenesis and increased BMI; this increase in fat mass weight also implies a health risk (Swinburn, Caterson, Seidell, & James, 2004). Finally, the CHO consumption in g/kg BW by women was lower than that of men (Table 1); however, this difference disappears when it is expressed in terms of the TEV%. This may be due to the fact that a higher CHO requirement is assumed for men compared to women. The non-significant differences in TEV% can be explained because men show a higher total energy consumption than women (Garcia-Roves et al., 2014).

The mean protein intake of women in the present study was adequate according to the recommendation of 12%-15% TEV. The relative g/kg BW/day was also adequate, with a recommendation of 1.4 to 1.7 g/kg BW/day. In males, the mean protein consumption complies with recommendations; however, the g/kg BW/day intake suggest an excessive consumption

above the recommended 2.1 g/kg BW. The literature reports protein intakes of 1.0 to 1.2 g/kg BW/day on female football players (Clark et al., 2003; Martin et al., 2006), which is lower than the values observed in the present study. In males, evidence shows intakes of 1.5 to 1.8 g/kg BW/day, with the exception of two studies (Hidalgo Terán Elizondo et al., 2015; Ruiz et al., 2005), in which high protein intakes are observed by young male soccer players, as in the present study. Similar to the CHO intake of the present study, the protein consumption in g/kg BW was significantly lower in women compared to men (Table 1); however, this difference disappears when expressed in TEV%. Again, men showed a higher energy consumption based on a greater quantity of macronutrient source foods (Garcia-Roves et al., 2014).

The mean fat consumption of the female players was close to the upper limit of the recommendation of 20%-30% TEV. This value was similar or lower to others reported before (Clark et al., 2003; Martin et al., 2006; Mullinix, Jonnalagadda, Rosenbloom, Thompson, & Kicklighter, 2003). Although the results show an adequate consumption of fat in percentages, it is close to the upper limit. In males, the energy distribution complies with the recommendations, which differs from previous reports showing an excessive caloric contribution from fats (Caccialanza et al., 2007; Garrido et al., 2007; Hidalgo Terán Elizondo et al., 2015; Iglesias-Gutierrez et al., 2012; Ruiz et al., 2005; Russell & Pennock, 2011), with the exception of the study by Bettonviel et al. (2016). Based on the seven-day food consumption qualitative analysis, men and women showed a high intake of saturated and trans fats from highly processed foods (e.g., sweet and salty pastries, fast foods such as French fries, fried chicken, pizza, hamburgers and nachos with highly processed cheeses and sausages and salty snacks such as potatoes and toasted tortillas). Finally, there is a lower consumption of fat (g) in women compared to men (Table 1); however, this difference disappears when expressed in TEV%.

In this study, all body composition variables were significantly different between males and females (Table 2). According to the reference model, the man is taller and heavier, with a heavier skeleton and has greater muscle mass, as well as a lower body fat content than the reference woman (McArdle, Katch, & Katch, 2015), which agrees with the findings of the present study. Women have specific additional essential fat, which averages four times the value of men (McArdle et al., 2015), reflecting a general higher BF%.

According to the American College of Sports Medicine (2014), 5.3% of the female team showed a BF% classified as “good” (17.6%-19.8%), 31.5% as “overweight” (24.2%-28.2%), and 63.2% were classified as “obese” (30.5% -38.6%). Beyond the search for adequate sports performance, these data show a significant health problem. Epidemiological studies have shown

that obesity is a risk factor for multiple diseases (De Pergola & Silvestris, 2013). The 18.2% of the males were classified based on their BF% as "excellent" (7.9%-10.5%), 40.9% "good" (11.5%-14.8%), 22.7% "acceptable" (15.8%-18.6%), 13.7% "overweight" (19.7%-23.3%), and 4.5% were classified as "obese" (American College of Sports Medicine, 2014). When analyzing the BF% of both, men and women, we found that 51.2% of the participants showed excess adiposity. Participants of the women's team represented the majority (89.5%) in comparison with men (18.2%).

When comparing the results obtained in the present research with similar national and international level research in elite and university male soccer teams (Chacón-Araya, Salicetti-Fonseca, & Moncada-Jiménez, 2016; Gerosa-Neto et al., 2014; Tunar et al., 2017), we found similar BF% among the various groups, mostly classified as "good". The BF% were classified as excellent compared to other studies on elite players in which DXA was used as a measurement method (Sutton, Scott, Wallace, & Reilly, 2009; Svantesson, Zander, Klingberg, & Slinde, 2008).

The number of studies found in females is lower compared to those found in the males, and most of these report BF% measured by skinfolds. The mean BF% obtained in the present study did not agree with those found in other studies (Stanforth, Crim, Stanforth, & Stults-Kolehmainen, 2014). However, other studies show a trend to high BF% in this population, where most football players are classified between "acceptable" and "overweight".

The present study provides the first body composition data for Costa Ricans female football players measured with a gold standard (i.e., DXA). Our study was similar to Stanforth et al. (2014) using the DXA in college football players, showing a mean BF% of 24.1%, while in the present study it was 31.4%, considered as obesity. It should be noted that female players of comparative studies have a higher competitive level than those of the present study, as well as a different training volume. The BF% is variable according to the training stage in which the players are. In the present study, both teams were in pre-season, stage in which various studies have found the highest BF% in football players (Bunc, Hráský, & Skalská, 2015).

In the present study, lean tissue was measured in legs and arms. Gerosa-Neto et al. (2014), conducted a study on Brazilian elite footballers. DXA scans were used to measure leg lean mass, obtaining higher values than those reported in the present study, with a similar height and BF%. Similarly, Silvestre, West, Maresh, and Kraemer (2006), reported higher results than those of the present study in American university players with a similar stature. In the case of the female team, no reference was found in the literature that would allow comparing the data obtained.

We estimated IMAT-SMM to describe in detail the body composition of the participants. Chacón-Araya et al. (2016), also reported these values in selected national and first division Costa Rican male players. The IMAT-SMM of professional players is slightly superior to the values obtained in the present study. We did not find comparison data for the female population; once again, this study being the first to investigate these variables in Costa Rican female college players.

Conclusions

No association was found between body composition and intake of CHO and proteins in any of the populations under study (global and by gender). There was an association in the intake of fat when it was analyzed globally, but not when analyzed by gender.

The energy intake and CHO by male and female players of the present study is excessive compared to literature reports. For protein, women have an adequate intake while men have an excessive intake. Male and female players have an adequate fat intake. The qualitative analysis of the diet reflects an unbalanced pattern of low nutritional quality, which agrees with other investigations with similar populations.

The body composition of most male players was normal, while for women it was excessive compared to international reports on football players. The values reported in the literature for male soccer players are similar to those obtained in the present study, with the exception body height and leg lean mass. For female soccer players, higher values were found than those reported in the literature, mainly for BF%.

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