

Anthropometry and Body Composition of Elite Brazilian Soccer Players according to the Playing Position

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Abstract

Aim: The aim of this study was to examine the differences in anthropometric characteristics and body composition of elite soccer athletes, according to playing position and function performed.

Methods: Ninety-seven elite athletes (24.68 ± 4.21 years) from a first division team of Brazilian soccer were assessed for body mass, stature and seven skinfolds, to determine body mass index, fat percentage, as well as fat mass and fat-free mass. Differences in the anthropometric characteristics and body composition, according to playing positions and function performed were evaluated with the Multivariate Analysis of Variance (MANOVA). Quantitative chances of finding differences and effect sizes (ES) were also interpreted.

Results: Goalkeepers (GO) and central defenders (CD) had likely to most likely higher stature and body mass than fullbacks (FB), defensive (DM) and offensive (OM) midfielders, and forwards (FW) (ES varying between 0.92 and 2.62); DM had also higher body mass than OM (ES=1.04). GO likely to very likely had higher body fat percentage and fat-free mass than other positions (ES varying between 1.49 and 2.07). OM likely to very likely had lower fat mass than GO, CD and DM (ES varying between 1.04 to 2.06). FB likely to very likely had also lower fat mass than GO and CD (ES=1.29 and 1.73, respectively).

Conclusion: Our results provide useful information for help coaches and other soccer professionals in the planning and control of training and nutrition in elite Brazilian soccer athletes.

Keywords: Soccer; Anthropometry; Body composition

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Introduction

Knowledge about physical characteristics necessary for high-level performance has been a great challenge for sport professionals and scientists [1]. Due to technical, scientific and methodological advances in high-performance sports, these information has been investigated in different sports, such as volleyball [2], handball [3], basketball [4], among others [5]. Therefore, the monitoring of physical variables is common in soccer clubs to develop strategies to increase performance and reduce injuries [6,7], as well as to determine the degree of physical readiness for competitions, in addition to assessing training effects and nutritional strategies adopted [1,8].

Anthropometric characteristics such as height, body mass, and body mass index are often emphasized in talent selection [9,10] and monitoring of athletes to the elite level [1,11]. Martinez-Santos et al [12] observed higher height and weight values in Spanish elite professional soccer athletes compared to semi-

professional athletes, although body fat and body mass index were not assessed. Body composition is also an important variable for monitoring soccer players and athlete selection, since appropriate fat levels allow more efficient actions in the game,

in addition to being associated with aerobic capacity and sprints [13]. However, considering the specific needs of each position and function performed, the requirements for anthropometric characteristics and body composition may be different [1,14].

Considered a complex and intermittent sport, due to its periods of high intensity efforts followed by low recovery periods, soccer performance depends on several factors (technical, tactical, physical and psychological) and its needs may vary according to the different playing positions [1,15]. Studies have shown some specific performance positions (goalkeepers, defenders, midfielders and forwards), although these differ in their characteristics and demands according to the function performed [1,16,17], for example central defenders' may differ from fullbacks, just as there may be differences between defensive and offensive midfielders.

Previous data on anthropometric profile and body composition in elite athletes has shown that defenders, without distinction of central defenders and fullbacks, are taller compared to midfielders and forwards [1,14,16]. Higher values of percentage fat and fat mass are also found in goalkeepers concerning athletes in other positions [18], while midfielders have the lowest percentage values of fat in relation to athletes in other positions [19]. However, there is also evidence of an absence of differences between athletes in different positions [20,21]. To the best of our knowledge, there isn't any study that had examined the real quantitatively chance of finding differences between playing positions in anthropometry and body composition of elite Brazilian soccer athletes.

Thus, the purpose of the present study was to examine the differences in the anthropometric characteristics and body composition of elite soccer players, according to the playing position. We hypothesize that the anthropometric characteristics and body composition of elite athletes differ according to the position of the performance, as well as the function performed.

Methods

Sample

One hundred and seven soccer players (24.77 ± 4.41 years) from a first division team in Brazilian league participated in this study [goalkeeper (GO), $n=10$; central defenders (CD), $n=14$; fullbacks (FB), $n=18$; defensive midfielders (DM), $n=19$; offensive midfielders (OM), $n=14$; and forwards (FW), $n=32$]. All participants completed on average five training sessions per week and participate in 60 to 70 official matches per year, distributed in four to five annual competitions (Brazilian Championship - First Division, Brazilian Cup - National, Northeast Cup - Regional, Pernambuco Championship - State, and occasionally the Sudamericana Cup, Continental). This study is based on all players' assessment records carried out in August between the years 2015 to 2018, the period between the fifth and tenth round of the national league. All procedures were approved by the Ethics Committee of the University of Pernambuco (CAAE: 02789018.5.0000.5192; Protocol number: 3048990). While approval to conduct the study was granted by the club and athletes, the data collection formed part of the team's routines in which players are assessed across the season.

Procedures

The evaluation of the anthropometric profile included measurements of body mass, height and skinfolds. Body mass was measured with a Filizola scale (Filizola®, São Paulo, Brazil), with accuracy to the nearest 0.1 kg and a maximum capacity of 150 kg. Height was measured with a portable stadiometer attached to the wall (Sanny, São Paulo, Brazil), with accuracy to the nearest 0.1 cm and a length of two meters. Based on these measures, the body mass index was calculated by dividing body mass by the square of height, with values expressed in kg/m^2 .

Thicknesses of seven skinfolds (subscapular, middle axillary, tricipital, medial thigh, supra-iliac, abdominal and chest) were measured in duplicate in the right hemibody of each athlete, with a third measurement being taken whenever the difference was greater than 0.2 mm, using a Lange caliper (Lange, Santa Cruz, California, USA), whose precision is given in millimeters (mm). The total body density was estimated based on the proposition of Jackson and Pollock [22], while the fat percentage was determined by the Siri equation [23]. Values of fat mass and fat-free mass were identified from information on the percentage of fat and body mass.

All evaluations were carried out in the club's physiology department by the same professional specialized in sports medicine, certified by the International Society for the Advancement of Kinanthropometry (level 2). The measurements were taken at the same time of the day (between 8 am and 10 am), with the athletes fasting, usually at the beginning of the week, after at least 24 hours of rest.

Data analysis

Initially, the data were checked for normality using the Kolmogorov-Smirnov test and inspection of the histograms. The homogeneity of variance was assessed with the Levene test. Descriptive statistics (mean and standard deviation) were calculated for each variable. Differences between positions for anthropometric characteristics and body composition were evaluated with One-Way MANOVA, using Bonferroni's post hoc when a significant F value was detected. Quantitative chances of finding differences in the variables were assessed as follows: <1%, almost certainly not; 1–5%, very unlikely; 5.1–25%, unlikely; 25.1–75%, possible; 75.1–95%, likely; 95.1–99%, very likely; >99%, almost certain. If the chances of having better and poorer results were both >5%, the true difference was assessed as unclear. A likely difference (>75%) was considered as the minimum threshold to detect meaningful differences because of the lower probability of an error occurring in this range of probabilities to find positive/negative effects [24]. The magnitudes of the mean differences (95% CI) for the comparisons across all variables were analyzed using the standardized differences based on Cohen's d effect sizes. The magnitudes of the ESs were interpreted using the following thresholds values: 0.20, 0.60, 1.20, 2.0 and 4.0 for small, moderate, large, very large and extremely large effects, respectively [25]. All analyzes were performed using the SPSS 23 software, considering a significance level of $p \leq 0.05$.

Results

The number of athletes evaluated for each position (full backs, central defenders, defensive midfielders, offensive midfielders and forwards) and the descriptive statistics of the analyzed variables are shown in **Table 1**.

Likely to almost certainly differences were found for playing position in all the observed variables, except for BMI (**Table 2**). In body mass, GO likely to very likely has more than FB, OM and FW (ES varying between 1.16 and 1.82), whereas CD possibly to very likely has more than FB, OM and FW (ES varying between 0.92 and 1.82). In addition, DM likely has higher body mass than OM (ES=1.04). For height, GO likely to very likely has more than FB, DM, OM and FW (ES varying between 1.31 and 1.76); CD very likely to most likely has more than FB, DM, OM and FW (ES varying between 1.46 and 2.62).

Regarding body composition, GO likely to very likely has more body fat percentage than CD, FB, DM, OM and FW (ES varying between 1.49 and 1.74). In fat mass, GO likely to possibly has more than FB and OM (ES=1.29 and 1.52, respectively). CD likely to very likely has higher fat mass than FB, OM and FW (ES varying between 0.99 and 2.06). In addition, DM likely has fatter mass than OM (ES=1.04). For fat-free mass, GO very likely has more than CD, FB, DM, OM and FW (ES varying between 1.61 and 2.07).

Discussion

The aim of the present study was to examine differences in the anthropometric characteristics and body composition of elite Brazilian soccer players, according to the playing position and function performed. It was expected that the characteristics observed would differ according to the position and function performed. However, most research has been carried out considering anthropometric differences and body composition only four positions: goalkeepers, defenders, midfielders and forwards [1,20]. Other divisions can also be observed when athletes perform specific functions, such as central defenders or fullbacks, and offensive or defensive midfielder.

Studies have shown that certain anthropometric aspects, such as body weight control and higher stature, contribute to success in certain positions and game functions [14,15,28]. As expected, goalkeepers and central defenders showed higher stature compared to fullbacks, defensive and offensive midfielders, and forwards, as well as higher weight than other positions, except defensive midfielders. We emphasize that the average differences

in height vary between 7.84 cm and 10.96 cm, and can reach 17.43 cm, between some line positions (e.g., CD vs OM), when we consider the confidence intervals of the observed differences. In body mass, the average differences can vary between 7.10 kg and 14.71 kg (**Table 2**).

It is known that some game actions give advantage to taller goalkeepers and central defenders, especially in the interception of aerial balls and other game contacts. In addition, goalkeepers have a lower metabolic load compared to other players, since players in this position run shorter distances than others [26]. Rivilla-García et al [27] showed that Spanish La Liga goalkeepers run approximately 4 km per game, while central defenders, midfielders and attackers cover distances greater than 9 km per game. In addition, central defenders tend to cover shorter distances and perform fewer sprints than midfielders [28]. These aspects are also frequently considered in the talent selection process in soccer from the lower categories [29-31].

Appropriate fat levels are essential for physical performance, in addition to being used for assessing training effects and suggesting different nutritional strategies [14]. The excess fat mass also promotes inefficiency of the locomotion pattern, as well as disfavoring specific game actions, including jumps, changes of directions, speed, and agility abilities [1]. Similar to our findings, fat percentage of English Premier League players vary from 9.9 percent to 12.9 percent, depending on the position [21]. Despite the differences between positions in most game actions [1,32], our data showed no significant differences in the fat percentage according to the position and function performed.

Furthermore, the higher fat mass found in central defenders compared to the fullbacks, midfielders and forwards, may be related to the higher stature and mass observed in these athletes, without necessarily providing athletic disadvantages for the central defenders, since there were no differences in the fat percentage. However, Slimani & Nikolaidis [1], showed that the variability in the fat percentage, sex, somatotype, and level of competitiveness (amateur vs professional) are determining factors for athletic performance and choice of players. Nevertheless, our results disagree with the previous literature that showed a higher percentage of fat among goalkeepers and defenders [1,14].

Despite the findings of the present study, the cross-sectional design prevents in-depth knowledge about the changes that occur throughout the season, specifically related to the effects of training and nutritional strategies on the physiological and

Table 1 Descriptive results (mean ± standard deviation) of anthropometric and body composition variables according to the game position.

Variables	GO (n=10)	CD (n=14)	FB (n=18)	DM (n=19)	OM (n=14)	FW (n=32)	F
Height (cm)	188.13 ± 8.59	187.39 ± 2.62	176.67 ± 5.37	179.55 ± 4.70	176.43 ± 5.29	178.39 ± 7.13	10.15**
Body mass (kg)	88.70 ± 8.49	83.61 ± 4.09	73.88 ± 6.35	78.96 ± 5.42	71.99 ± 8.12	76.53 ± 8.83	7.41**
BMI (kg/m ²)	24.39 ± 1.09	23.84 ± 1.22	23.65 ± 1.34	24.49 ± 1.42	23.35 ± 1.60	23.98 ± 1.65	1.28
Body fat (%)	12.96 ± 2.39	9.12 ± 2.25	8.87 ± 2.78	9.54 ± 2.24	9.44 ± 2.27	8.82 ± 2.42	4.29**
Fat mass (kg)	11.31 ± 2.58	7.66 ± 2.07	6.78 ± 2.15	7.62 ± 1.68	7.01 ± 2.03	7.04 ± 2.35	6.24**
Fat-free mass (kg)	75.40 ± 6.95	75.95 ± 3.43	67.10 ± 5.93	71.34 ± 5.59	64.91 ± 6.81	69.48 ± 7.42	6.38**

Note: BMI: Body Mass Index; CD: Central Defenders; DM: Defensive Midfielders; FB: Full-Backs; FW: Forwards; GO: Goalkeeper; OM: Offensive Midfielders, **p<0.001; *p<0,05

Table 2 Mean differences (95% CI), ES and quantitative chances of finding differences for anthropometric and body composition variables for the different playing positions.

	Body mass	Height	Body fat	Fat mass	Fat-free mass
GO vs CD	3.05 (-6.25 to 12.37) ES: 0.51 (small) Possibly harmful	0.73 (-6.85 to 8.31) ES: 0.13 (trivial) Most unlikely	3.85 (0.76 to 6.93) ES: 1.66 (large) Very likely	-0.60 (-8.74 to 7.54) ES: -0.12 (trivial) Most unlikely harmful	3.65 (0.92 to 6.38) ES: 1.61 (large) Very likely
GO vs FB	12.83 (3.91 to 21.76) ES: 1.82 (large) Very likely	11.45 (4.18 to 18.73) ES: 1.76 (large) Very likely	4.23 (1.27 to 7.19) ES: 1.60 (large) Very likely	8.19 (0.38 to 16.00) ES: 1.29 (large) Likely	4.65 (2.03 to 7.26) ES: 2.07 (very large) Very likely
GO vs DM	7.82 (-1.02 to 16.67) ES: 1.23 (large) Likely	8.57 (1.36 to 15.78) ES: 1.41 (large) Likely	3.40 (0.47 to 6.34) ES: 1.49 (large) Likely	4.13 (-3.60 to 11.88) ES: 0.69 (moderate) Possible	3.68 (1.09 to 6.28) ES: 1.87 (large) Very likely
GO vs OM	14.71 (5.40 to 24.02) ES: 1.78 (large) Very likely	11.69 (4.11 to 19.28) ES: 1.76 (large) Very likely	3.52 (0.43 to 6.60) ES: 1.52 (large) Likely	10.48 (2.34 to 18.63) ES: 1.52 (large) Very likely	4.29 (1.56 to 7.02) ES: 1.92 (large) Very likely
GO vs FW	10.15 (1.85 to 18.45) ES: 1.16 (moderate) Likely	9.73 (2.97 to 16.49) ES: 1.31 (large) Very likely	4.17 (1.42 to 6.92) ES: 1.74 (large) Very likely	5.86 (-1.39 to 13.12) ES: 0.80 (moderate) Likely	4.29 (1.85 to 6.72) ES: 1.82 (large) Very likely
CD vs FB	9.78 (2.30 to 17.27) ES: 1.78 (large) Very likely	10.72 (4.62 to 16.82) ES: 2.44 (very large) Most likely	0.38 (2.09 to 2.86) ES: -0.15 (trivial) Most unlikely	8.79 (2.24 to 15.34) ES: 1.73 (large) Very likely	0.99 (1.19 to 3.19) ES: 0.47 (small) Possible
CD vs DM	4.77 (-2.63 to 12.17) ES: 0.99 (moderate) Unlikely	7.84 (1.81 to 13.87) ES: 1.98 (large) Very likely	-0.44 (-2.89 to 2.01) ES: -0.19 (trivial) Very unlikely	4.73 (-1.73 to 11.21) ES: 1.00 (moderate) Likely	0.03 (-2.13 to 2.20) ES: 0.01 (trivial) Most unlikely
CD vs OM	11.66 (3.73 to 19.60) ES: 1.82 (large) Very likely	10.96 (4.49 to 17.43) ES: 2.62 (very large) Most likely	-0.32 (-2.95 to 2.30) ES: -0.14 (trivial) Most unlikely	11.09 (4.14 to 18.03) ES: 2.06 (very large) Very likely	0.64 (-1.68 to 2.97) ES: 0.31 (small) Unlikely
CD vs FW	7.10 (0.37 to 13.83) ES: 0.92 (moderate) Possible	9.00 (3.51 to 14.48) ES: 1.46 (large) Very likely	0.32 (-1.90 to 2.55) ES: 0.13 (trivial) Most unlikely	6.46 (0.57 to 12.35) ES: 0.99 (moderate) Likely	0.63 (-1.33 to 2.60) ES: 0.28 (small) Unlikely
FB vs DM	-5.02 (-11.93 to 1.89) ES: -0.86 (moderate) Possibly harmful	-2.89 (-8.52 to 2.74) ES: -0.57 (small) Possibly harmful	-0.82 (-3.11 to 1.46) ES: -0.33 (small) Unlikely	-4.05 (-10.10 to 1.98) ES: -0.70 (moderate) Possibly harmful	-0.96 (-2.99 to 1.06) ES: -0.51 (small) Possibly harmful
FB vs OM	1.88 (-5.61 to 9.36) ES: 0.26 (small) Unlikely	0.23 (-5.86 to 6.33) ES: 0.04 (trivial) Most unlikely	-0.70 (-3.18 to 1.77) ES: -0.27 (small) Unlikely	2.29 (-4.25 to 8.84) ES: 0.35 (small) Unlikely	-0.35 (-2.54 to 1.84) ES: -0.17 (trivial) Most unlikely
FB vs FW	-2.69 (-8.87 to 3.50) ES: -0.34 (small) Likely	-1.72 (-6.76 to 3.31) ES: -0.26 (small) Unlikely	-0.05 (-2.11 to 1.99) ES: -0.02 (trivial) Most unlikely	-2.32 (-7.74 to 3.08) ES: -0.33 (small) Unlikely	-0.36 (-2.17 to 1.45) ES: -0.16 (trivial) Most unlikely
DM vs OM	6.89 (-0.50 to 14.28) ES: 1.04 (moderate) Possible	3.12 (-2.90 to 9.15) ES: 0.63 (moderate) Possible	0.11 (-2.33 to 2.56) ES: 0.05 (trivial) Most unlikely	6.35 (-0.12 to 12.82) ES: 1.04 (moderate) Likely	0.61 (-1.55 to 2.78) ES: 0.33 (small) Unlikely
DM vs FW	2.33 (-3.75 to 8.41) ES: 0.30 (small) Unlikely	1.16 (-3.79 to 6.11) ES: 0.18 (trivial) Most unlikely	0.76 (-1.25 to 2.77) ES: 0.32 (small) Unlikely	1.72 (-3.59 to 7.05) ES: 0.25 (small) Unlikely	0.60 (-1.18 to 2.38) ES: 0.28 (small) Unlikely
OM vs FW	-4.56 (-11.92 to 2.17) ES: -0.53 (small) Possibly harmful	-1.96 (-7.44 to 3.52) ES: -0.29 (small) Unlikely	0.65 (-1.58 to 2.88) ES: 0.27 (small) Unlikely	-4.62 (-10.51 to 1.26) ES: -0.63 (moderate) Possibly harmful	-0.01 (-1.98 to 1.96) ES: -0.004 (trivial) Most unlikely

Note: CD: Central Defenders; DM: Defensive Midfielders; FB: Full-Backs; FW: Forwards; GO: Goalkeeper; OM: Offensive Midfielders

performance-related characteristics of these athletes. However, our study maintained the standardization of the annual evaluation period, this avoids any undue bias due to the influence of the competitive period on the observed characteristics. The absence of more precise measures to assess body composition, such as bioimpedance or DXA, was not possible for this study. However, skinfold measurements were performed using a standardized application, performed by a trained professional with extensive experience (ISAK level 2).

Given that the study was conducted in only an elite team, the generalization of the results should be done with caution. On the other hand, we emphasize that this study was conducted with a large number of athletes evaluated in each position and function of game. Thus, our findings providing a complement to the literature when we observe that the differences, or absence, observed, are also perceived according to the function performed. Still, another strong point is the inclusion of athletes from the first division of the Brazilian championship, which

indicates its importance for the production of knowledge in high-level Brazilian soccer.

Conclusion

In conclusion, goalkeepers and central defenders showed higher stature, fat mass and fat-free mass when compared to most different positions and functions in the game. Additionally, defensive midfielders also showed an increase in fat mass when compared to the offensive midfielders. These data provide

useful information for assist coaches and soccer professionals in planning, controlling training and nutrition in elite Brazilian soccer players. Future studies should seek answers to some of the questions raised as limitations of this study and evaluate physical, functional, nutritional parameters, among others, in elite Brazilian soccer players.

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