

## Body composition analysis of athletes from the elite of Brazilian soccer players

### Análise da composição corporal de atletas da elite do futebol brasileiro

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#### ABSTRACT

This study analyzed the body composition and bone mineral density of elite Brazilian soccer players and compared its differences according to the player position. Eighty-two soccer players competing at Brazilian first division were split according to their field positions: Goalkeepers (GK, n= 10), Backfielders (BF, n= 10), Lateral-midfielders (LM, n= 15), Central-midfielders (CM, n= 25), Forwards (FW, n= 22), and a Control Group (CG, n= 72) of university students. To estimate fat free mass (FFM), fat mass (FM), percentage of body fat (%FM), fat free mass of legs (FFM-Legs) and bone mineral density (BMD), a DEXA was selected. The positions LM ( $10.5 \pm 5.2$ ), CM ( $9.7 \pm 4.0$ ) and FW ( $9.9 \pm 4.4$ ) had lower values of FM and %FM than the GK ( $17.3 \pm 6.0$ ) and the control group ( $15.0 \pm 5.3$ ). Compared to the other positions, FFM was higher in the GK ( $68.2 \pm 10.9$ ) and BF ( $64.6 \pm 6.8$ ) ( $p < 0.05$ ). All the soccer players were different from the CG ( $p < 0.05$ ). Soccer players have an FFM, FFM-Legs and BMD significantly higher and FM and %FM lower than the control group.

*Keywords:* athletes, muscle mass, bone density, DXA

#### RESUMO

Este estudo analisou a composição corporal e densidade mineral óssea de atletas da elite do futebol brasileiro e comparar as diferenças entre as posições de jogo. Oitenta e dois jogadores de futebol da primeira divisão do Brasil foram divididos de acordo com a posição de jogo. Goleiros (GL, n= 10), Defensores (DF, n= 10), Laterais (LT, n= 15), Centrais (CT, n= 25), Atacantes (AT, n= 22) e um grupo controle (CG, n= 72). Para estimar a massa livre de gordura (MLG), massa gorda (MG), percentual de massa gorda (%MG), massa livre de gordura de pernas (MLG-Pernas) e densidade mineral óssea (DMO), foi usado o DEXA. A posição LT ( $10.5 \pm 5.2$ ), CT ( $9.7 \pm 4.0$ ) e AT ( $9.9 \pm 4.4$ ) apresentaram menores valores de MG e %MG que os GL ( $17.3 \pm 6.0$ ) e GC ( $15.0 \pm 5.3$ ). Comparado a outras posições, a MLG foi maior nos GL ( $68.2 \pm 10.9$ ) e DF ( $64.6 \pm 6.8$ ) ( $p < 0.05$ ). Todos os jogadores apresentaram diferenças significativas em relação ao grupo controle ( $p < 0.05$ ). Em suma, conclui-se que atletas da elite do futebol brasileiro apresentaram significativamente maior MLG, MLG-Pernas, DMO e menor MG e %MG que o grupo controle.

*Palavras-chave:* atletas, massa muscular; densidade mineral óssea

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## INTRODUCTION

Soccer is considered the most popular sport in the world, being practiced in almost all nations (Reilly & Williams, 2003), and as sporting performance evolves, concerns about the factors involved in its improvement increases, so that the monitoring of body composition variables to achieve better results becomes more important. Accordingly, given morphological characteristics obtained in the anthropometric assessments and in the body composition (body mass [BM], height, fat free mass [FFM] and fat mass [FM]) are important to excel in soccer.

Due to the size of the soccer pitch and the duration of the game, each player performs one specific function within the team, showing specific physical characteristics (Davis, Brewer, & Atkin, 1992; Goulding et al., 2009; Silvestre, West, Maresh, & Kraemer, 2006; Sporis, Jukic, Ostojic, & Milanovic, 2009)

Aside from some research which has been carried out with these athletes (Carling & Orhant, 2010; Casajus, 2001; Davis et al., 1992; Franks, Williams, Reilly, & Nevill, 1999; Reilly, Bangsbo, & Franks, 2000; Rhodes et al., 1986; Rienzi, Mazza, Carter, & Reilly, 1998; Silvestre et al., 2006), sports science has been more dedicated to the studies of aerobic and anaerobic fitness, with less attention given to the morphological variables, which are generally studied by a bi-compartmental model of evaluation ( $BM = FFM + FM$ ).

Research having as main framework multi-compartmental models in which the body is split into three or more components is a must (Heymsfield, Wang, Visser, Gallagher, & Pierson, 1996), allowing a detailed study that takes into consideration the distribution of the FFM in a segmented way. Additionally, there are few studies that have investigated the body composition of Brazilian soccer players, and analyzed according to field position. Thus, the objective of the present study was to analyze the body composition and bone mineral density of athletes from elite Brazilian soccer teams

and to compare the differences between the field positions.

## METHODS

The study has a cross-sectional design and was carried out in 2010 and 2011 at the University Estadual Paulista (UNESP) - Presidente Prudente - SP.

### Participants

The sample was split into two groups: 82 soccer players ( $23.6 \pm 4.2$  years,  $179.9 \pm 8.1$  cm and  $77.0 \pm 12.7$  kg) that can be broken-down into their position. The players were classified as forwards (FW,  $n = 22$ ), goalkeepers (GK,  $n = 10$ ), lateral-midfielders (LM,  $n = 15$ ), central-midfielders (CM,  $n = 25$ ) and backfielders (BF,  $n = 10$ ), players from the Brazilian soccer first division; and a Control Group (CG) which consisted of 72 university individuals ( $24.7 \pm 4.8$  years,  $177.7 \pm 5.6$  cm e  $76.5 \pm 7.6$  kg) who did not practiced systematic physical activity.

These athletes competed in a league with 20 teams and the season lasted for 11 months of the year. Because there are only a few breaks over the season, data collection was done during the pre-season.

From an ethical point of view, the related project was approved by the Ethics Research Group of the university (Protocol nº 48/2010). All participants were fully informed about the nature and demands of the study, as well as the known health risks. They completed a health history questionnaire and were informed that they could withdraw from the study at any time. All participants signed a written consent form.

### Instruments and Procedures

#### *Anthropometry and Body Composition*

Body mass was measured with an electronic weighting scale (Filizola®), with a maximum capacity of 180 kg and a precision of 0.1 kg. Height was measured with a fixed stadiometer (Sanny ®), with an accuracy of 0.1 cm and

a length of 2.20 m.

To estimate fat free mass, fat mass, percentage of body fat, fat free mass of legs and bone mineral density, an absorptiometry device for X-ray of Dual-energy (DEXA) of Lunar brand was used, DPX-MD, software 4.7 The DEXA body composition was estimated by dividing the body into three anatomical compartments: fat-free mass, fat mass and bone mineral density (BMD). Results are reported in grams of lean mass, fat and body fat percentage (Lohman, Roche, & Heymsfield, 1996). This technique also allows the estimation of total and segmental body composition. Thus we estimated the total body composition and lower limb.

The determination of the body regions was done according to Silvestre et al. (2006). All evaluations were performed in competitive pre-season.

### Statistical Analysis

For the statistical analysis the Kolmogorov-Smirnov test was used to verify the normality. After the descriptive analysis for the sample characterization, the *t* Student test for independent samples was selected to verify the differences between the soccer players and the

control group. The Levene test for verifying homogeneity of variance of a data set was carried out in addition to One-Way analysis of variance (ANOVA) following the Tukey Post Hoc test in order to verify the possible differences between the player positions. All analyzes were performed using BioEstat software (version 5.0). The significance level was 5%.

### RESULTS

Table 1 presents the main characteristics of the soccer players and the control group. Comparing both groups a significant difference was observed in the soccer players for all the body composition variables and the height. There was no difference in age or weight.

Table 2 presents the different body compositions according to player position. The positions LM ( $10.5 \pm 5.2$ ), CM ( $9.7 \pm 4.0$ ) and FW ( $9.9 \pm 4.4$ ) had lower values of FM and %FM than both the GK ( $17.3 \pm 6.0$ ) and the control group ( $15.0 \pm 5.3$ ). Compared to the other positions, FFM was higher in the GK ( $68.2 \pm 10.9$ ) and BF ( $64.6 \pm 6.8$ ) ( $p < 0.05$ ). No significant differences were verified in FFM-Legs among the athletes groups but all of them presented significantly higher values than the CG ( $p < 0.05$ ).

Table 1

Values of body composition and bone mineral density expressed as mean, standard deviation, interquartile range of the soccer players and the control group

	Soccer Players (n= 82)	Control (n= 72)	<i>p</i>
Age (years) #	23.9 (6.9)	24.1 (6.3)	0.113
Weight (kg) #	77.0 (12.8)	76.0 (8.6)	0.770
Height (cm)	179.9± 8.1	177.7± 5.6	0.046
FM (kg)	11.3± 5.1	15.0± 5.3	≤ 0.001
FM (%)	14.0± 5.2	19.4± 5.8	≤ 0.001
FFM (kg) #	61.9 (7.5)	58.2 (7.7)	≤ 0.001
FFM-Leg (kg)	24.6± 2.4	21.7± 2.6	≤ 0.001
BMD (g/cm <sup>3</sup> )	1.42± 0.84	1.30± 0.09	≤ 0.001

Note: # = no-parametric analyze;  $p < 0.05$ ; FM (kg) = fat mass in kilograms; FFM = fat free mass in kilograms; FM% = percentage of fat mass; FFM-Leg = fat free mass of legs in kilograms; BMD = bone mineral density in g/cm<sup>3</sup>

Table 2

Comparison of body composition and bone mineral density between the control group and soccer players, according to the field position

	Control (n= 72)	Goalkeeper (n= 10)	Backfielder (n= 10)	Lateral (n= 15)	Central (n= 25)	Forward (n= 22)
Age (year) <sup>#</sup>	24.1(6.3)	23.5 (9.6)	24.8 (4.7)	24.0 (8.6)	22.7 (6.5)	23.6 (8.2)
Weight (kg) <sup>#</sup>	76.0 (8.6)	93.1 (14.1) <sup>a</sup>	81.0 (10.2) <sup>a</sup>	76.8 (15.0) <sup>b,c</sup>	74.6 (8.5) <sup>b</sup>	75.1 (14.5) <sup>b</sup>
Height (cm)	177.7±5.6	191.0± 4.3 <sup>a</sup>	186.2± 5.0 <sup>a</sup>	178.0± 5.8 <sup>b,c</sup>	176.5±5.2 <sup>b,c</sup>	177.3±9.0 <sup>b,c</sup>
FM (kg)	15.0± 5.3	17.3± 6.0	13.3± 3.5	10.5± 5.2 <sup>a,b</sup>	9.7± 4.0 <sup>a,b</sup>	9.9± 4.4 <sup>a,b</sup>
FM (%)	19.4± 5.8	18.8± 5.2	16.0± 3.8	13.4± 5.5 <sup>a</sup>	12.8± 4.7 <sup>a,b</sup>	12.7± 4.8 <sup>a,b</sup>
FFM (kg) <sup>#</sup>	58.2 (7.7)	68.2 (10.9) <sup>a</sup>	64.6 (6.8) <sup>a</sup>	61.8 (6.3) <sup>a,b</sup>	61.7 (2.9) <sup>a,b</sup>	59.8 (8.1) <sup>a,b</sup>
FFM-Leg (kg)	21.7± 2.6	26.1± 2.7 <sup>a</sup>	25.7± 2.5 <sup>a</sup>	24.4± 1.7 <sup>a</sup>	24.3± 2.0 <sup>a</sup>	24.0± 2.9 <sup>a</sup>
BMD (g/cm <sup>3</sup> )	1.30±0.09	1.45± 0.05 <sup>a</sup>	1.41±0.06 <sup>a</sup>	1.41± 0.07 <sup>a</sup>	1.43± 0.11 <sup>a</sup>	1.41± 0.07 <sup>a</sup>

Note: <sup>#</sup>= no-parametric analyze; <sup>a</sup>= Tukey's post-hoc test with *p*-value < 0.05 compared to Control Group; <sup>b</sup>= Tukey's post-hoc test with *p*-value < 0.05 compared to goalkeepers; <sup>c</sup>= Tukey's post-hoc test with *p*-value < 0.05 compared to backfielders. FM (kg)= fat mass in kilograms; FFM= fat free mass in kilograms; FM%= percentage of fat mass; FFM-Leg= fat free mass of legs in kilograms; BMD= bone mineral density in g/cm<sup>3</sup>

## DISCUSSION

The aims of this study were (i) to analyze and compare body composition and bone mineral density in elite Brazilian soccer athletes with a control group, (ii) and to compare according to the field position.

In this study the soccer players, when compared to the control group, showed differences in all variables, but for age and weight, showing the effect of specific training in this sport. The average percentage of fat found in soccer players was 14%, values similar to those found by Silvestre et al. (2006) (13.9%) and Matkovic et al. (2003) (14.9%) with first division players from Connecticut and Croatia respectively. However, they are all higher than those shown by Sutton, Scott, Wallace, and Reilly (2009) who evaluated four of the elite English soccer teams. These differences may be due to the instruments used and evaluation period (pre-season or period of competitions), as well as the competitive level of the participants. Gissis et al. (2006) analyzed the values of body fat in soccer players according to their competitive level in the Greek league teams, showing significantly lower values in the best placed teams.

Sutton et al. (2009) showed that body fat and bone mineral density are the best variables to discriminate soccer players from the control group, according to multiple regression models, this effect was observed in the goalkeepers. In the study by Sutton et al. (2009) goalkeepers showed higher values of body fat percentage when compared to other field positions. These results are similar to those found in this study; however, goalkeepers only differed from midfielders and attackers.

These differences in fat percentage between goalkeepers and defenders from the remaining positions may be due to the characteristics required in training and games. Reilly (1997) noted that goalkeepers and defenders run on average 4 and 8 km, respectively, in a match, while in other positions the distance can reach 12 km. So it is natural that goalkeepers would have a lower aerobic capacity and a higher percentage of body fat.

Matkovic et al. (2003) and Arnason et al. (2004) reported greater differences between goalkeepers and other player positions, with goalkeepers being taller, heavier and having a higher fat percentage. In these two studies small differences between the other positions

(goalies excluded) were also found.

In this research, goalkeepers also had a higher absolute amount of fat-free mass compared to the control group, the laterals, midfielders and attackers. However, when only the fat-free mass of the legs was analyzed the difference found was only in relation to the control group. Sutton et al. (2009) used the percentage of fat-free mass and found no differences between the positions of play. These two pieces of information show the importance of different forms of analysis.

Soccer players have differences in all body composition variables. In this study goalkeepers and defenders were taller and heavier than the players from the sidelines, the midfield and the attack. However, the values of fat-free mass are influenced by different types of methods which can be used for estimation of the body composition and how the values are used (absolute and relative).

There were no differences in BMD between soccer players, according to field position, but when the soccer players were compared with the control group there were differences ( $p \leq 0.001$ ). Fredericson et al (2007), compared the BMD of soccer players with runners and sedentary men, and noted that soccer players' total BMD only showed a difference with the control group, which is similar to our findings. The highest BMD values found among players can be explained, because soccer is a sport that involves activities and intermittent high intensities, which include sprinting, jumping, accelerations, decelerations and quick changes of direction, which involve the stimulation of acquiring bone mineral (Heinonen, Sievanen, Kyrolainen, Perttunen, & Kannus, 2001; Robling, Hinant, Burr, & Turner, 2002).

The data from the present study provides an insight of the anthropometric characteristics and the body composition of professional soccer players. That said, some limitations should be addressed. The goalkeeper being a position with a smaller number of athletes on the team, the data collection season and not having a diet control group.

The results of this study show that soccer players have specific morphological characteristics related to body composition as compared to a control group. However, only goalkeepers differed as compared to the other player positions.

## CONCLUSIONS

It is possible to conclude that the Brazilian professional soccer players studied in this study showed significant differences in body composition compared to non-players. According to the field position, goalkeepers and defenders were taller and heavier than the players from the sidelines, the midfield and the attack.

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### Conflicts of Interest:

Nothing to declare.

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