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Body composition in young male football (soccer) players

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Abstract

The aim of the study was to assess body composition by anthropometry in school-age children playing football (soccer) and to compare the results with those of a reference group. We studied 239 children aged 9.0 to 14.9 years who played this sport in a local league. We compared them with a reference population of 453 children in the same age range. We measured weight, height, four skinfold thicknesses, and two circumferences; and we calculated body mass index, total body fat percentage, fat free mass, arm fat percentage, and arm muscle area. Body mass index do not showed any significant difference between football (soccer) and reference groups in any age category. The percentage of total body fat was significantly lower in the football (soccer) group than in the reference group at 9, 11, 12, and 14 years. In studies aiming to assess the effect of physical activity on body composition, it will be necessary to measure, not only body mass index, but other measures of the body fat compartment. Football (soccer) can be proposed as a physical activity practice aiming to prevent or treat obesity and its comorbidities.

Keywords: Physical activity; Body fat; Skinfolds; Circumferences; Energy expenditure; Obesity

1. Introduction

Football (soccer) is the most widely practiced sport in Europe. Different aspects related with this sport have been studied, but mainly in professional and young adult players [1,2]. In Europe, children participate in this sport for at least two or three times per week. Therefore, this is an important way to increase their physical activity.

Some reports have showed that in children, elevated physical activity levels are associated

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with low body fat. Sunnegårdh et al. [3] observed, in a random sample of 682 Swedish children 8 years and 13 years of age, that children characterized by high habitual physical activity tended to have lower body fat, despite a higher energy intake, than less active children. Longitudinal studies also demonstrated the beneficial effect of exercise on body composition [4,5].

Exercise intensity in football (soccer) ranges from standing and walking to sprinting, covering a mean distance close to 11 km at an average intensity comparable to that observed during marathon running (70−80% of the maximal oxygen uptake) [6]. Despite this similarity in average intensity, football (soccer) is an intermittent high-intensity exercise.

Although there are many studies relating physical activity to body composition, only a few of them considered specific activities. Therefore, we have assessed body composition by a complete set of anthropometric measurements in school-age children playing football (soccer) and we have compared the results with those of a reference group, to examine the effect of participation in this sport on body composition.

2. Methods and materials

We studied 239 children aged 9.0 to 14.9 years who played football (soccer) in the age-specific local league for this sport. We compared their body composition with that of a reference population obtained by us in the same city; from 453 children in the same age range. Written informed consent was obtained from the parents of all the children. The football (soccer) players were competing once a week in a local age-specific league. The players carried out a 3-hour per week training divided into 2 days. No information on the physical activity of the reference group has been obtained. The study protocols were approved by the Ethical Committee, University Hospital (Zaragoza, Spain).

All the anthropometric measurements were taken three times by the same technician. We measured all the anthropometric variables in order, and then we repeated the same measurements a second and a third time. Body mass index (BMI) was calculated as body weight (in kilograms) without shoes and with light clothing, divided by height (in meters) squared. Body weight was measured to 0.05 kg using a standard beam balance. Height was measured to the nearest 1 mm using a Harpenden stadiometer.

Skinfold thickness were measured in the left side of the body, to the nearest 0.1 mm, with a Holtain skinfold caliper, at the following sites: 1) triceps, halfway between the acromion process and the olecranon process; 2) biceps, at the same level as the triceps skinfold, directly above the center of the cubital fossa; 3) subscapular, about 20 mm below the tip of the scapula, at an angle of 45° to the lateral side of the body; and 4) suprailiac, about 20 mm above the iliac crest and 20 mm toward the medial line [7].

Circumferences were also measured with an unelastic tape. For measuring the arm circumference, the subjects stand relaxed with their side to the observer, the arm hanging freely at the side; the tape was passed around the arm at the level of the midpoint of the upper arm. To measure the waist circumference, the tape was applied horizontally midway between the lowest rib margin and the iliac crest about the level of the umbilicus, at the end of gentle expiration [7,8].

Table 1
Body composition in male children aged 9 years

	Reference group		Football (soccer) group		*P* Value
	Median	IQR	Median	IQR	
N	110		36		
Weight (kg)	32.25	9.58	32.25	6.88	NS
Height (m)	1.36	0.10	1.36	0.12	NS
BMI (kg/m^2)	17.14	3.30	17.50	3.03	NS
Sum 4 skinfolds (mm)	32.85	28.18	31.50	14.80	<0.05
% Body fat	15.64	12.26	14.97	8.60	<0.05
Fat-free mass (kg)	26.69	5.11	27.64	5.35	NS
Waist circumference (cm)	61.70	8.57	60.50	6.75	NS
Arm fat (%)	34.78	12.75	30.24	12.29	<0.001
Arm muscle area (cm^2)	21.08	5.01	28.45	6.03	<0.05

BMI = body mass index; IQR = inter quartile range.

Body density was calculated using the formula described by Brook [9]:

$$\text{Density} = 1.1690 - 0.0788 \times (\text{log sum of 4 skinfolds}) \quad (1)$$

Density was converted to an estimate of relative body fat (%) using the equation of Weststrate and Deurenberg [10]:

$$\text{Body fat (\%)} = [562 - 4.2\,(\text{age} - 2)]/\text{d} - [525 - 4.7\,(\text{age} - 2)] \quad (2)$$

The Weststrate and Deurenberg equation [10] was constructed on the basis of published data on increases in the density of fat-free mass with age in children. This equation provides the best prediction performances during childhood and adolescence [11].

Body composition indices based on arm measurements were calculated using the equations described by Jellife [12]:

$$\text{Arm muscle area} = [\text{Arm circumference} - (\pi\,\text{triceps skinfold})]^2/4\pi \quad (3)$$

$$\text{Arm fat area} = [(\text{Triceps skinfold} \times \text{arm circumference})/2] - [(\pi\,\text{triceps skinfold}^2)/4] \quad (4)$$

Statistical analyses were performed with SPSS software (SPSS, Chicago, IL). The distribution of quantitative variables was tested for normality using the Kolmogorov-Smirnov test with the Lilliefors correction. All the variables showed a non-gaussian distribution in both football (soccer) and reference groups; therefore, all variables were described with median and interquartile range. Comparisons between groups were done with the Mann-Whitney *U* test.

3. Results

In Tables 1 to 6 we show body composition characteristics in both football (soccer) and reference groups, in each age category. BMI did not show any significant difference between

Table 2
Body composition in male children aged 10 years

	Reference group		Football (soccer) group		*P* value
	Median	IQR	Median	IQR	
N	81		46		
Weight (kg)	36.00	8.50	36.50	7.88	NS
Height (m)	1.43	0.07	1.42	0.09	NS
BMI (kg/m^2)	17.60	3.65	18.52	2.85	0.05
Sum 4 skinfolds (mm)	35.30	25.65	36.92	24.45	NS
% Body fat	17.37	11.74	18.36	11.33	NS
Fat-free mass (kg)	29.52	4.51	30.14	5.12	NS
Waist circumference (cm)	63.80	10.00	65.00	8.02	NS
Arm fat (%)	37.09	13.88	31.72	12.89	0.01
Arm muscle area (cm^2)	21.92	5.14	25.73	6.72	0.0001

Abbreviations as in Table 1.

soccer and reference groups in any age category. Percentage of body fat was significantly lower in the football (soccer) than in the reference group at 9, 11, 12, and 14 years. Fat-free mass was only higher in the football (soccer) than in the reference groups at 13 and 14 years of age. Waist circumference did not show any significant difference between groups at any age category. Relative arm fat (%) showed significant differences between groups at all the age categories with lower fat percentage measured in the football (soccer) group than in the reference group. Arm muscle area showed higher values in the football (soccer) group than in the reference group at all the age categories, except at 11 years.

4. Discussion

The present study compared different body composition indicators between a group of adolescent football (soccer) players and a reference group. Because voluntary physical

Table 3
Body composition in male children aged 11 years

	Reference group		Football (soccer) group		*P* value
	Median	IQR	Median	IQR	
N	70		44		
Weight (kg)	39.75	15.12	39.00	7.38	NS
Height (m)	1.48	0.10	1.45	0.09	<0.01
BMI (kg/m^2)	18.02	5.12	18.05	2.98	NS
Sum 4 skinfolds (mm)	38.00	45.18	29.70	16.70	<0.01
% Body fat	19.29	16.28	15.67	15.91	<0.01
Fat-free mass (kg)	32.09	5.90	32.42	4.79	NS
Waist circumference (cm)	65.15	15.18	64.00	6.45	NS
Arm fat (%)	37.83	16.69	28.48	8.50	0.0001
Arm muscle area (cm^2)	23.51	6.12	25.65	7.22	NS

Abbreviations as in Table 1.

Table 4
Body composition in male children aged 12 years

	Reference group		Football (soccer) group		*P* value
	Median	IQR	Median	IQR	
N	61		44		
Weight (kg)	43.00	10.00	41.50	6.75	NS
Height (m)	1.53	0.09	1.51	0.08	NS
BMI (kg/m^2)	18.47	2.77	18.16	3.41	NS
Sum 4 skinfolds (mm)	37.40	28–90	26.80	17.60	<0.05
% Body fat	20.50	11.89	14.78	8.69	0.01
Fat-free mass (kg)	33.01	6.28	34.19	6.75	NS
Waist circumference (cm)	66.50	7.70	65.00	7.88	NS
Arm fat (%)	35.26	16.87	25.08	11.81	0.0001
Arm muscle area (cm^2)	26.26	5.30	28.12	5.40	<0.05

Abbreviations as in Table 1.

activity related energy expenditure is the most variable component of total energy expenditure [13], its implication in maintaining energy balance is of major importance. Low energy expenditure is associated with a positive energy balance that favors obesity [14]. It has been suggested that the prevalence of obesity has been increasing over the last few decades because of the decrease in voluntary energy expenditure [15,16].

The results of our study point to a trend toward a lower percentage of body fat in football (soccer) players than in the reference group. The differences were more evident when considering the percentage of body fat at the arm level rather than total body fat percentage. Fat-free mass was higher in the football (soccer) group than in the reference group, mainly at the older age categories and when taking into account the arm muscle area. No significant effect of this sport on body fat distribution assessed by waist circumference was observed.

In children 8–16 years of age, it was observed that boys who reported 6–8 sessions of vigorous activity per week had the highest BMIs, whereas those who reported three or fewer

Table 5
Body composition in male children aged 13 years

	Reference group		Football (soccer) group		*P* value
	Median	IQR	Median	IQR	
N	77		31		
Weight (kg)	51.00	15.50	51.50	9.00	NS
Height (m)	1.61	0.12	1.61	0.11	NS
BMI (kg/m^2)	19.35	3.23	19.53	3.10	NS
Sum 4 skinfolds (mm)	33.00	21.90	28.00	14.60	NS
% Body fat	18.58	9.88	15.89	7.13	NS
Fat-free mass (kg)	39.03	9.37	43.44	7.46	<0.05
Waist circumference (cm)	69.30	8.50	68.50	8.00	NS
Arm fat (%)	28.58	14.79	23.10	9.98	<0.05
Arm muscle area (cm^2)	30.72	8.81	33.19	6.54	<0.05

Abbreviations as in Table 1.

Table 6
Body composition in male children aged 14 years

	Reference group		Football (soccer) group		*P* value
	Median	IQR	Median	IQR	
N	54		38		
Weight (kg)	54.50	15.50	56.50	9.50	NS
Height (m)	1.65	0.10	1.68	0.06	NS
BMI (kg/m^2)	19.97	4.20	20.53	2.34	NS
Sum 4 skinfolds (mm)	30.20	21.32	26.30	13.02	<0.05
% Body fat	18.19	9.69	15.87	6.85	<0.05
Fat-free mass (kg)	45.17	9.01	47.61	6.62	<0.05
Waist circumference (cm)	72.05	9.68	70.25	5.62	NS
Arm fat (%)	26.51	10.91	19.84	9.55	<0.001
Arm muscle area (cm^2)	33.77	8.61	37.82	7.65	<0.01

Abbreviations as in Table 1.

sessions of vigorous activity per week had the lowest BMIs. In the girls, no clear trend was noted. In both boys and girls, there was not a significant effect of physical activity on body composition assessed by means of skinfold thickness [17].

In a previous study of children aged 13–14 years from the general population, we observed that the amount of physical activity was not related to BMI in either boys and girls; however, it was related significantly to fat deposition in adolescent girls, but not in boys [18,19]. In 373 male adolescents, Dionne et al. [20] also observed that body weight, fat mass, body mass index, sum of six subcutaneous skinfolds, trunk and extremity skinfolds, and trunk to extremity skinfolds ratio were all significantly and inversely related to a higher degree of participation in vigorous physical activity. In our study, we have not observed a significant effect on body fat distribution assessed by the measure of waist circumference, which is a good indicator of visceral fat accumulation and its complications [8].

In a longitudinal study of 86 healthy children followed-up from 10 months to 10 years, Deheeger et al. [21] observed that, despite a higher energy intake in the active group, active and less active children had similar BMI at the age of 10 years. However, their body composition differed significantly: active children had a higher proportion of fat-free mass, a lower proportion of fat-mass as measured in the arm, and a later adiposity rebound. We have also observed higher amounts of fat-free mass in children playing football (soccer) than in the reference group, especially at the older ages and when considering the arm muscle area.

In a longitudinal study of 200 adolescents, Kemper et al. [22] observed that the relationship between fat mass and physical activity, when corrected for dietary intake, showed a significant inverse relationship if fat mass was estimated from the sum of four skinfolds, but not if it was estimated from the BMI.

In a meta-analysis of studies focusing on exercise treatment of obesity, LeMura et al. [23] concluded that exercise is efficacious for reducing selected body composition variables in children and adolescents. The most favorable alterations in body composition occurred with: low-intensity, long-duration exercise; aerobic exercise combined with high repetition resistance training; and exercise programs combined with a behavioral modification component.

Recently, Gutin et al. [24] observed that, compared with a group on lifestyle education alone, obese adolescents in two physical training programs showed favorable changes in percentage body fat and visceral adipose tissue.

In summary, we can consider that young male football (soccer) players showed lower percentage of total and arm body fat than the reference group. In accordance with other studies, we have observed that the effect of this type of exercise is not evident when we consider the BMI. In future epidemiological studies aiming to assess the effect of physical activity on body composition, it would be necessary to measure not only the BMI but also other measures of body fat. From this point of view it seems that body composition indices obtained from arm measurements are more sensitive to the effect of physical activity than total body composition indices. We have not observed any effect of football (soccer) on body fat distribution assessed by the waist circumference. This sport can be proposed as a physical activity practice aiming to prevent or treat obesity and its comorbidities.

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