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Effects of 12-week soccer training on anthropometric characteristics and body image perception in pre-adolescent boys

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SHORT TITLE: Soccer training effects in pre-adolescent boys

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It is recognised that physical activity (PA) improves nutritional status and reduces risk of disease, enhances body image perception, and reduces body dissatisfaction (1-3). Whereas the relationship of PA with body composition and body image perception have been extensively investigated in adults, few or contradictory studies on effects of specific sport activities in children or adolescents have so far been reported (2).

Our study aimed (i) to gain a better understanding of body composition and body image perception in 60 pre-adolescent boys by carrying out an evaluation of their anthropometric characteristics and body image perception before and after a 12-week soccer training program, (ii) to analyse possible differences between age-groups (9 year-group: 24 boys; 10 year-group: 36 boys).

All children of two soccer schools, native-born in the same area of Northern Italy (province of Ferrara), volunteered to participate in the study. The amount of soccer training was the same for each subject (4 hours/week). Written informed consent was obtained from the parents. The study was approved by the Ethics Committee of Ferrara University.

Participants underwent assessment of their anthropometric measurements and body image perception. Height was recorded to the nearest 0.1 cm with a stadiometer, while weight was measured to the nearest 0.1 kg with a high-precision mechanical scale. Skinfold thicknesses were measured to the nearest 1 mm at two sites (triceps and subscapular) using a Lange skinfold caliper. Waist and middle upper-arm circumferences were measured to the nearest 0.1 cm with a non-stretchable tape. All the measurements were made according to standardized procedures and when applicable on the left side of the body as indicated in the International Biological Program (4). The same trained technicians team performed all the examinations on the subjects in light sportswear and barefoot. BMI was calculated for each participant as weight (in kg) divided by height (in m) squared. The boys were classified as underweight, normal weight, overweight or obese based on international age- and sex-specific cut-off points (5-6). In order to assess the body composition of each child, total body fat percentage (%F), fat mass (FM, kg) and fat free mass (FFM, kg) were calculated using the formulas of Slaughter et al. (7). Total upper arm area (TUA, cm^2), upper arm muscle area

(UMA, cm^2), upper arm fat area (UFA, cm^2) and arm fat index (AFI, %) were calculated using the formulas of Frisancho (8).

The children were asked to answer some questions regarding their self-perception: the self-reported height and weight. For the evaluation of body image perception, they were asked to choose which one of seven silhouettes (9) best represented their perceived (feel) and ideal body shape. Silhouettes were arranged in ascending order from smallest to largest body size in a row on a single page. The faces of silhouettes were replaced by generic circles (10). The assessment took place individually under the supervision of the same trained research assistant. The discrepancy between the self-feel figure and the self-ideal figure represents the degree of body image dissatisfaction (FID). To assess inconsistency in the perception of their weight status, the Feel weight status minus Actual weight status Inconsistency Index (FAI) (11) was used. According to previous studies on FAI in children (12-13), we assigned a code for feel weight status: F1 and F2 were coded 1 for underweight, F3, F4 and F5 were coded 2 for normal weight, and F6 and F7 were coded 3 for overweight/obesity. The FAI scores in children range from -2 to +2: a negative value means weight status underestimation while a positive value means weight status overestimation. A 0 score means a realistic perception of one's weight status.

Differences between age groups were analysed using independent t-test (anthropometric data) and U Mann-Whitney test (body image perception). The effect of the 12-week soccer training on the same subjects was explored using paired-sample t-test (anthropometric data) and Wilcoxon test (body image perception). Analysis of categorical variables (weight status) was performed using chi-square test. Statistica software (v.11, StatSoft Italia srl, Padua, Italy) was used for all analyses. The significance level for all tests was set at $p<0.05$.

Table 1 shows the mean values of each anthropometric variable and weight status by age and by survey (before and after training). After the 12-week soccer training, the 9-year group showed a significant increase in height, weight, and FFM, while the 10-year group showed a significant increase in height, weight, UMA and FFM and a significant decrease in triceps skinfold, sum of skinfolds, UFA and AFI. Before training, the 10-year-old children had

higher mean values than the 9-year-olds, as expected. In particular, the significant differences (p<0.05) were in height (+7.9 cm), weight (+7.4 kg), waist circumference (+5.1 cm), middle upper-arm circumference (+2.4 cm), triceps skinfold thickness (+5.1 mm), subscapular skinfold thickness (+4.3 mm), Σ skinfolds (+9.4 mm), TUA (+8.2 cm^2), UFA (+6.1 cm^2) and AFI (+7.9%). Significant differences were also found in FM (+2.1 kg) and FFM (+4.3 kg).

Table 2 shows the mean values of body image perception by age and by survey. No difference was found in the 9-year group between the values before and after the 12-week training. In the 10-year group the FID index significantly decreased in the second survey. Despite the 10-year-old boys were fatter than the younger ones -as shown by skinfold thicknesses, %F, FM, UFA and AFI-, they chose slightly thinner feel silhouettes than the 9-year group. The ideal figures were almost the same. Hence the level of dissatisfaction (FID) was somewhat lower in this group than in the 9-year-olds, especially at the second survey. The mean FAI index values show underestimation in both age groups (negative values) but especially in the 10-year group, in agreement with previous observations. Regarding the discrepancy between perceived height and weight and the actual ones, there were significant differences only for weight. Both age groups thought they were thinner than they actually were (9-year group: 31.7 kg perceived weight vs 32.5 kg actual weight, p<0.05; 10-year group: 37.7 kg perceived weight vs 39 kg actual weight, p<0.01).

This study suggests changes in body image perception and anthropometric parameters of 9-10-year-old soccer players after the 12-week training period. The 10-year-old soccer players showed greater anthropometric changes and lower body image dissatisfaction after this period than the 9-year-olds. These results are probably due to the greater effort put into the training by the older children. In contrast to a previous study highlighting an increase in body image dissatisfaction with increasing PA in 11 to 14 years (14), our observations and other studies (15) suggest a positive effects of PA in enhancing body image perception in children. These differences may be due to an increase in body awareness and concern about weight and shape, leading to an increase in body dissatisfaction during adolescence. Body

dissatisfaction may be increasing in boys, especially in those exercising at high levels, as they may desire a more muscular figure. Furthermore, the age effect should also be considered, as body dissatisfaction evolves from childhood through late adolescence: 9- to 10-year-old boys report less body dissatisfaction than groups of older adolescent boys (16).

A few of the significant changes in the anthropometric traits in this study can be directly related to normal growth processes while others, although influenced by growth, were certainly affected by the soccer training. In particular there was an increase in FFM in both age groups. UMA increased, but UFA and AFI simultaneously decreased in the older boys. Differently from the 9-year-old boys, the 10-year-olds showed a significant decrease in FID after the 12 weeks of training. In their self-perception of body size, the boys of both groups showed a fairly objective judgement for height and a significant underestimation of weight, in accordance with the results obtained on Italian children not selected for sport (13).

The findings suggest a general improvement in body composition and body image satisfaction after 12 weeks of soccer training in pre-adolescence. However further studies with different training periods and a non-active control group are needed to better understand the role of soccer in nutritional and psychological health.

Our study is a contribution to the literature on children's body image perception since it involves the effects of soccer training in combination with those of growth during the intervention period. However the study has some limitations. The first is the restricted number of children under investigation and the lack of a control group so as to clearly differentiate the growth effects from those of the soccer training. The second is that the amount of PA was self-reported and not objectively measured.

The finding that boys who regularly play soccer have good perception of their body and a suitable body composition is encouraging and speaks in favour of an active lifestyle starting in the pre-adolescence period. Our results provide interesting, also if preliminary, observation showing effects of a soccer training program in improving children's physical and psychological health. Future studies should focus on the benefits of exercise, according to the amount and types, at various ages and in both sexes. Finally, given the protective

effects of body satisfaction, its development during adolescence and the influence exerted on it by PA must be carefully assessed so as to plan effective interventions.

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Table 1 Comparisons of anthropometric traits and weight status by age and survey.

	9 years old (*N*=24)		10 years old (*N*=36)	
	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)
Traits				
Height (cm)	133.3 (8.3)	134.4 (8.4)*	141.2 (5.6)	142.3 (5.8)*
Weight (kg)	32.6 (7.4)	33.1 (7.7)*	39.0 (7.4)	39.8 (7.6)*
BMI (kg/m^2)	18.1 (2.4)	18.1 (2.5)	19.4 (2.9)	19.6 (3.1)
Waist C (cm)	61.7 (6.7)	61.7 (6.6)	66.8 (6.7)	66.7 (6.5)
Upper-arm C (cm)	20.3 (2.6)	20.5 (2.5)	22.7 (2.8)	22.8 (2.7)
Triceps Sk (mm)	11.2 (4.4)	11.6 (4.7)	16.3 (6.6)	15.5 (6.5)*
Subscapular Sk (mm)	7.2 (5.0)	7.5 (4.8)	11.5 (6.4)	11.1 (5.5)
Σ Sk (mm)	18.4 (8.8)	18.9 (8.6)	27.8 (12.3)	26.6 (11.3)*
TUA (cm^2)	33.4 (9.0)	33.8 (8.4)	41.6 (10.0)	41.8 (9.8)
UMA (cm^2)	22.7 (4.8)	22.8 (4.7)	24.7 (4.4)	25.7 (4.6)*
UFA (cm^2)	10.7 (5.3)	11.0 (5.4)	16.8 (7.8)	16.1 (7.6)*
AFI (%)	30.8 (7.7)	31.6 (8.6)	38.7 (11.1)	36.8 (11.4)*
%F	18.6 (6.2)	17.7 (6.1)	21.1 (4.9)	21.0 (5.6)
FM (kg)	6.3 (3.7)	6.1 (3.7)	8.4 (3.0)	8.6 (3.4)
FFM (kg)	26.2 (4.9)	26.9 (5.1)*	30.5 (4.8)	31.2 (4.9)*
Weight Status (%)				
underweight	0.0	0.0	2.8	5.6
normalweight	75.0	70.8	58.3	55.6
overweight/obese	25.0	29.2	38.9	38.8

C=circumference; Sk=skinfold; TUA= Total Upper Arm Area; UMA=Upper Arm Muscle Area; UFA=Upper Arm Fat Area; AFI=Arm Fat Index; F=Fat; FM=Fat Mass; FFM=Fat Free Mass.
*p< 0.05 between pre and post intervention.

Table 2 Comparisons of body image perception by age and survey.

	9 years old (*N*=24)		10 years old (*N*=36)	
	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)
Actual Figure	4.5 (0.8)	4.3 (0.9)	4.2 (1.1)	4.1 (1.1)
Ideal Figure	3.8 (1.2)	3.8 (1.0)	3.7 (0.9)	3.9 (0.8)
FID (score)	0.6 (1.4)	0.5 (1.2)	0.5 (1.1)	0.2 (1.0)*
FAI (score)	-0.2 (0.4)	-0.2 (0.5)	-0.4 (0.5)	-0.4 (0.6)

*p<0.05 between pre and post intervention.