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Comparison of body weight, body height and body fatness of Italian children aged 6-12 years with American standards

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World Health Organization has suggested that American standards may be adopted for use in countries where no local reference data are available. Since no locally accepted growth standard is available in Italy, this study investigated if American growth curves for weight, height and triceps skinfold (TSF) provide reliable values for Italian children. Weight, height and TSF were measured in 1273 Italian children (boys: 656, girls: 617) ranging in age from 6 to 12 years and their percentiles were compared with that provided by NCHS for American children. Despite some minor differences, it is shown that American standards can be used safely in Italian children aged from 6 to 12 years.

Key words: **Weight - Height - Triceps skinfold, Growth - Child.**

Body weight and body height are essential parameters to follow growth and development in children. [1] Normally, these parameters are measured regularly from birth, and in case of deviation from normal values, e.g. a low height for age, indicating growth retardation, or an high weight for height, indicating overweight or obesity, adequate action can be taken. Many countries develop their own growth standards, which have the advantage that differences in stature and/or in weight for height, which may have an ethnic basis, are taken into account. However the development of such standards requires a lot of work, and thus, is very expensive. Besides, standards must be kept up to date, as in many societies there is a secular growth in the population, which is ascribed to improved levels of food quality, better environmental conditions and improved medical treatment of diseases. Growth standards are available for many western countries, for example in the USA, [2] in the United Kingdom, [3 4] and in Canada. [5] It is important that such standards are developed in large and representative samples and that the used methology is well described. All standards are in fact population-specific. That specificity can be a disadvantage, as a «normal» population can be judged too thin by a standard which was developed in a relatively fat population. In Italy, there are

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TABLE I.—*Body weight, body height, body mass index (BMI), triceps skinfold (TSF) thickness and percent body fat (%BF) in Italian male children aged 6-12 years (mean±SD).*

Parameters	6	7	8	9	10	11	12
N. cases	56	88	74	78	120	126	114
Weight (kg)	21.9±2.3	25.9±4.0	29.0±4.6	32.4±6.3	37.2±6.1	41.9±9.2	44.8±11.1
Height (cm)	118±4	124±5	129±5	135±6	141±6	147±7	151±8
BMI (kg/m^2)	15.9±1.4	16.8±1.9	17.3±2.3	17.6±2.7	18.8±2.3*	19.3±3.3*	19.5±3.7*
TSF (mm)	8.1±2.4	9.2±3.0	10.4±4.1	11.0±4.4	12.8±4.4*	13.9±6.6*	13.5±7.2*
%BF	16.7±2.8	17.3±2.9	17.8±4.1	18.0±4.4	19.3±3.8	19.4±5.2	18.0±5.5

* P<0.001 vs 6 years

TABLE II.—*Body weight, body height, body mass index (BMI), triceps skinfold (TSF) thickness and percent body fat (%BF) in Italian female children aged 6-12 years (mean±SD).*

Parameters	6	7	8	9	10	11	12
N. cases	53	81	81	72	108	124	98
Weight (kg)	23.0±3.1	25.0±3.6	27.9±4.5	32.5±4.8	36.5±8.1	40.9±8.7	45.7±8.8
Height (cm)	119±5	123±5	128±5	134±5	140±7	146±7	153±7
BMI (kg/m^2)	16.2±1.6	16.4±2.0	16.9±2.2	18.1±2.2*	18.4±3.0*	19.0±3.1*	19.5±3.2*
TSF (mm)	9.6±2.7	11.2±3.7	12.4±3.7	14.3±4.8*	14.3±5.5*	14.4±5.6*	14.3±5.9*
%BF	17.5±3.2	19.1±4.2	19.7±4.1	21.8±4.7	21.1±5.3	21.6±5.5	21.1±5.1

* P<0.001 vs 6 years

no population specific standards, but only few studies have been done in all population. [6]

However, the World Health Organization suggests that American standards may be adopted for use in countries where no local reference data are available. [7 8] The aim of the present study was, therefore, to assess whether the American growth curves provide reliable standards for Italian children aged from 6 to 12 years.

Materials and methods

Body weight, body height and skinfold thickness were measured in 1273 children aged 6-12 years. Three hundred and twenty nine children came from the north of Italy (Modena city and its surroundings) and 944 from the south of Italy (Cosenza and Foggia). For this purpose, primary schools were visited, and after having obtained permission from the parents of the children, body weight (in underwear) and body height (without shoes) were measured to the nearest 0.1 kg and 0.1 cm respectively. From body weight and body height, body mass index (BMI) was calculated as weight/height^2 (kg/m^2). Skinfold thickness was measured using a Holtain caliper at the triceps, biceps, subscapular and suprailiac sites, as described by Durnin & Womerseley.[9] The measurements were taken in triplicate to the nearest 0.1 mm and the mean value of the measurements was used for statistical analyses. From the sum of the four skinfolds, percent body fat (%BF) was calculated using the formulas of Deurenberg *et al.*[10] Age was noted in whole years, 6 years being from 6.0 to 6.99 years, ecc. The SPSS program was used for statistical analysis. Group means were compared by «t» statistics or by analysis of variance techniques (ANOVA). Differences between ages within each sex were tested with the Student-Neumann-Keuls procedure. Percentile values were calculated and compared with the published data of the reference population as published by the American National Center of Health Statistics.[2 11] The level of statistical significancy was set to a $p<0.05$. Values are expressed as mean ± standard deviation.

Results

Table I provides the values and their SD of body weight, body height, BMI, triceps skinfold (TSF) and %BF for the boys of each age group. In Table II the same data are given for girls. As exptected, weight and height increased with age, but diffe-

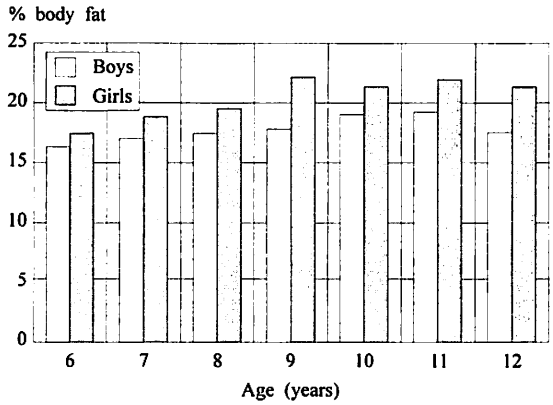

Fig. 1.—Percent body fat of Italian boys and girls of difference ages.

TABLE III.—*Mean values (corrected for age) of body weight, body height, body mass index (BMI), triceps skinfold (TSF) thickness and percent body fat (%BF) of Italian boys and girls aged 6-12 years.*

Parameters	Boys (n=656)	Girls (n=617)
Weight (kg)	37.5	36.9
Height (cm)	140.6	140.0
BMI (kg/m^2)	18.5	18.4
TSF (mm)	11.8	13.7*
%BF	18.2	20.7*

* P<0.001

rences between the age groups in BMI, TSF and BF are less clear. In boys , the BMI a age 10, 11 and 12 years differed from the BMI at age 6, in girls the BMI at age 9, 10, 11 and 12 years differed from the value at age 6 years. The triceps skinfold in boys was only from 10 years on different from the value at age 6 years. In girls the triceps was from 9 years on different from the value at age 6 years.

In Figure 1, %BF for boys and girls at different ages is given graphically. Table III indicates that the differences between boys and girls were only significant for triceps skinfold and total body fat, not for weight, height and BMI. In Table IV the values for the 10th (p10), 50 th (p50) and 90th (p90) percentile of body weight, body height and TSF for boys and girls of each age group are given. In Figures 2, 3 and 4 (A=boys, B=girls) the p10, p50 and p90 for body weight, body height and TSF are plotted together with the standard values of the NCHS. Generally, body weight, body height and TSF in the Italian children was higher compared to the standard values, these differences were slightly more pronounced in boys. However, these

TABLE IV.—*Percentile (p10, p50, p90) values of body weight, body height and triceps skinfold (TSF) thickness in Italian boys and girls aged 6-12 years*

Age	Weight (kg)			Height (cm)			TSF (mm)		
	p10	p50	p90	p10	p50	p90	p10	p50	p90
boys									
6	18.8	21.8	24.4	112	118	122	5.5	7.5	12.0
7	21.1	25.1	31.4	117	124	132	5.8	8.7	13.6
8	23.4	28.5	35.5	123	129	137	6.0	9.6	16.2
9	25.3	30.5	42.2	128	135	144	5.4	10.0	17.5
10	30.0	36.5	47.2	132	140	149	7.6	12.0	20.0
11	31.4	39.7	55.8	138	147	156	6.7	12.7	23.4
12	32.0	42.5	62.9	142	150	163	6.4	10.4	24.7
girls									
6	18.7	23.0	26.8	112	120	125	6.2	9.0	14.4
7	20.5	24.7	30.0	118	124	129	6.6	10.9	16.6
8	22.0	28.1	35.0	122	129	134	7.4	12.4	17.4
9	26.2	32.5	38.2	128	134	140	8.8	14.0	21.6
10	28.1	34.5	50.5	132	140	151	8.1	12.7	22.4
11	31.0	40.4	52.3	137	147	156	8.0	13.5	23.6
12	36.5	44.5	57.6	142	154	161	7.5	14.0	21.9

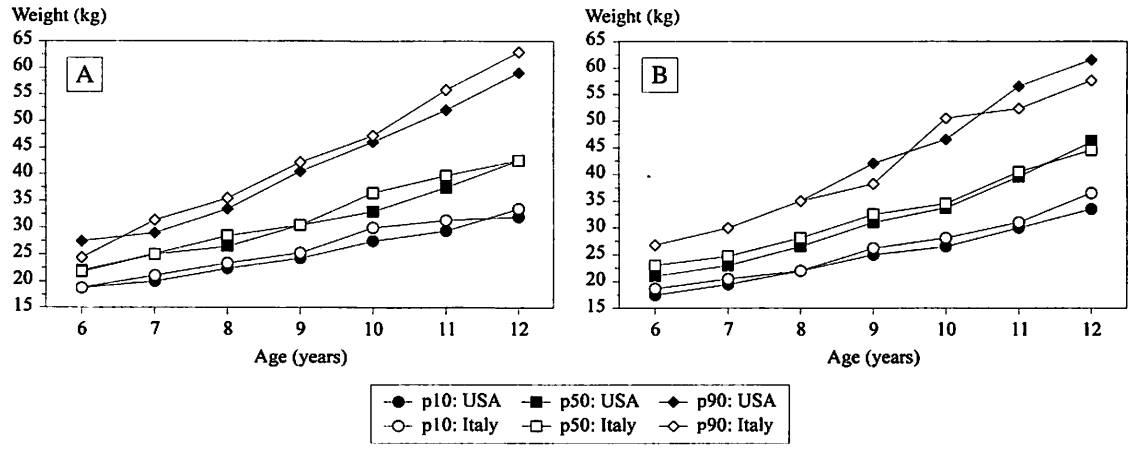

Fig. 2.—Comparison of body weight of Italian children aged 6-12 years with American standards.

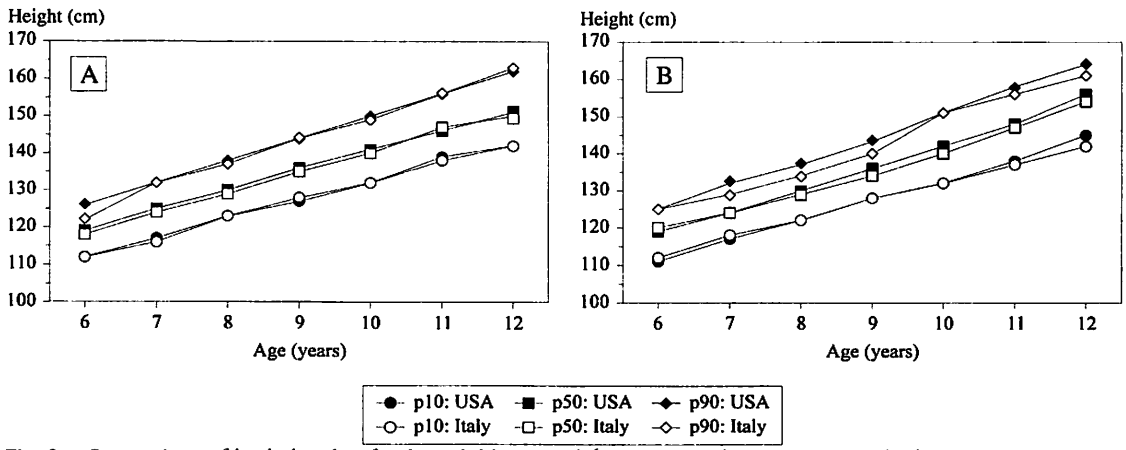

Fig. 3.—Comparison of body height of Italian children aged 6-12 years with American standards.

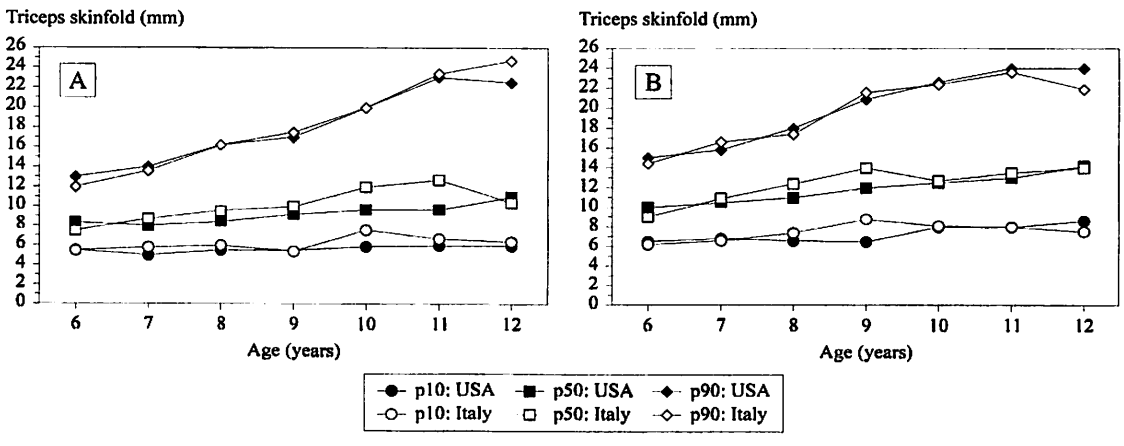

Fig. 4.—Comparison of triceps skinfold of Italian children aged 6-12 years with American standards.

differences were small and not statistically significant.

Discussion and conclusions

The children measured in the present study were not representative sample of the Italian paediatric population of the same age. Although, the children were randomly recruited in primary schools in both north and south Italy, they were not classified for social economic class or other parameters which could influence body weight and growht in special. However, no clear and systematic differences were seen between the boys and the girls of each age group with reference to their provenience from north or south Italy (unpublished data). Thus, despite the fact that the study sample may be not completely representative of the Italian population, it may give a good impression of body weight, body height, BMI and TSF of the Italian children ranged in age between 6 and 12 years. The changes in body weight and body height show both in boys and girls a pattern that can be expected, namely a steadily increase of these parameters with age. Also, BMI increases, consequently to the larger increase in body weight compared to body height. This increase in body mass index with age is reported in the literature. [11 13] Furthermore, TSF show a slight increase with age, more pronunced in females than in males. This is also known from the literature. [11 13] From the sum of four skinfolds, body fat was assessed, using age specific prediction formulas. [10] The data show an equal percent of body fat in boys and girls at age 6, but after that age %BF becomes higher in females. At age 12, %BF decreases slightly in both boys and girls, indicating the growth spurt, for which an excess of energy is needed, which is derived from the energy (fat) stores of the body. [14] An earlier growth spurt in girls is reported many times in the literature, [11 13 14] and can also be observed in this population as can be read from Table I and II for body height in boys and girls respectively. Also, the more pronounced increase in body weight in girls from age 11 indicates an earlier start of the growth spurt. As the growht spurt is not occurring in every subject at the same age, the variability in body composition parameters increases at the time the spurt begins. This can be clearly seen in males at age 12 for body weight, and for females from age 11 to 12 for weight and to a lesser extent for height and body fat.

The percentiles (p10, p50, p90) for weight, height and triceps skinfold thickness coincided well with the values of the american standards. Generally, at lower ages the italian children tended to have a higher body weight, a lower body height and a higher fat (based on TSF) than their American counterparts. However, the differences are minor, and they disappear after the age of 11, except for the triceps skinfold thickness in females, which remains slightly higher than the standards. From this study it can be concluded that the American standards can be used safely as growth standards in the Italian paediatric population aged 6-12 years.

References

1. Seefeldt VD, Harrison GG. Infants, children and youth. In: Lohman TG, Roche AF, Martorell R, editors. Anthropometric Standardization Reference Manual. Champaign IL: Human Kinetics Books, 1988:111-4.
2. Frisancho A. Anthropometric Standards for the Assessment of Growth and Nutritional Status. Ann Arbor: The University of Michigan Press 1990:189.
3. Tanner JM, Whitehouse RH, Takaishi M. Standards from birth to maturity for height, weight, height velocity and weight velocity: British children 1965 Arch Dis Child 1966;41:454-71,613-25.
4. Tanner JM, Whitehouse RH. Revised standards for triceps and subscapular skinfolds in British children. Arch Dis Child 1975;50:142-5.
5. Nutrition Canada. Anthropometry Report: Height, Weight and Body Dimension. Ottawa: Bureau of Nutritional Sciences, Health Protection Branch, Health and Welfare, 1980.
6. Bulgarelli R, Rainero L, Cinque N. I valori auxologici medi normali del bambino nelle diverse regioni italiane. Infanzia 1965;17(Suppl.).
7. WHO (World Health Organization). Measuring Change in Nutritional Status. Guidelines for assessing the Nutritional Impact of Supplementary Feeding Programmes for Vulnerable Groups. Geneva: WHO 1983.

8. WHO (World Health Organization). A Growth Chart for International Use in Maternal and Child Health Care. Geneva: World Health Organization, 1978.
9. Durnin J, Womerseley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurement on 481 men and women aged from 16 to 72 years. Br J Nutr 1974;32:77-97.
10. Deurenberg P, Pieters JJ, Hautvast JG. The assessment of body fat percentage by skinfold thicknesses measurement in childhood an young adolescence. Br J Nutr 1990;63(2):293-303.
11. Hamil PVV, Drizd TA, Johnson CL, Reed RB, Roche RC, Moore WM. Physical growth: National Center for Health Statistics percentiles. Am J Clin Nutr 1979; 32:607-29.
12. Rolland-Cacherà MF, Cole TS, Sempè TF, Tichet J, Rossignol C, Charraud A. Body mass index variation: centiles from birth to 87 years. Eur J Clin Nutr 1991;45(1):13-21.
13. Westrate JA, Deurenberg P, Van Tinteren H. Indices of body fat distribution and adiposity in Dutch children from birth to 18 years of age. Int J Obesity 1989;465-77.
14. Forbes GB. Body composition in infancy, childhood and adolescence. In: Forbes GB, editor. Human Body Composition. Growth, Aging, and Activity. New York: Springer-Verlag, 1987;125-96.