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PAPER

Anthropometry and body composition in ethnic Japanese and Caucasian adolescent girls: considerations on ethnicity and menarche

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OBJECTIVE: This study aimed to compare the various anthropometric and body composition parameters based on the ethnicity and the absence or presence of menarche.
DESIGN: A cross-sectional study with incomplete sampling, using the subject as the evaluation unit.
SUBJECTS: The final sample of 550 subjects was composed of 122 Japanese and 179 Caucasian premenarcheal adolescents, and 72 Japanese and 177 Caucasian postmenarcheal adolescents.
METHODS: The variables of body composition were measured through the following methods: bioelectrical impedance analysis, near-infrared interactance (NIR), Slaughter cutaneous skinfold equations and body mass index. Weight, height and sitting height were also evaluated.
RESULTS: The Japanese pre- and postmenarcheal girls presented lower weight and height values when compared with the Caucasian girls. In general, the Japanese premenarcheal girls presented less fat and fat-free mass than the premenarcheal Caucasian girls. This fact was demonstrated through NIR results. Conversely, the Japanese postmenarcheal adolescents accumulated more fat than their Caucasian counterparts. However, significant differences were solely encountered in the values of cutaneous skinfold percent body fat. With regard to menarche, it was verified that, regardless of ethnicity, all the anthropometric and body composition variables reached higher values among postmenarcheal adolescents when compared with premenarcheal adolescents.
CONCLUSION: Different results of weight and height between the ethnic groups may bring back the discussion concerning separate growth curves for different ethnic groups. The results of the body composition analysis indicated high adiposity levels among postmenarcheal adolescents.
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Keywords: Japanese adolescent; Caucasian adolescent; menarche; foot-to-foot bioelectrical impedance; near-infrared interactance; cutaneous skinfold; body mass index

Introduction

The effect of environmental conditions on development, including growth, maturation and the fulfillment of genetic potential, can be identified through the study of the variations found among different ethnic groups in the same population, or in the comparison of ethnic groups from distinct countries.

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In 1975, the participants of a workshop on the physical growth of several ethnic groups, encountered in the United States of America, concluded that 'although anthropometric differences have been demonstrated among several ethnic groups living under similar environmental conditions in various parts of the world, the use of a single standard for height and weight is unlikely to cause serious errors'.[1] Mainly with respect to operational aspects, by and large, the adoption of a single growth standard is coherent; however, a few studies have indicated quite different genetic potentials under the same socioeconomic condition. Concerning the Asian groups, seldom have anthropometric studies been conducted,[2–4] and from the existing ones, a large number involve samples of subjects from 20 to 30 y

ago.[5–7]One of the rare studies on the growth of a Japanese group in Brazil[8] corroborates findings of other studies conducted with children whose Asian parents or grandparents had migrated to various parts of the world.[5,7] These studies have demonstrated that well-fed children of Asian origin and high socioeconomic status present lower height-for-age values than those of American and European reference standards.

Population studies of body composition may be useful, although the impossibility of adopting precise and sophisticated methods, such as the laboratorial ones, may represent a disadvantage. Body mass index (BMI), an alternative to these methods, is frequently used to evaluate the subject's nutritional status with a special focus on obesity. Several studies have revealed a poor relation between the BMI and the percent body fat, despite its wide utilization.[9–11] Additionally, there has been strong evidence that ethnicity may interfere with the relation between the BMI and the percent body fat.[2,12–15]

Bipedal bioimpedance (BIA)[16] and near-infrared interactance (NIR)[17] methods have been adopted as an alternative to the BMI, and cutaneous skinfolds in body composition studies of large samples.

Consideration of the variable ethnicity within diverse studies may provide aid in the planning of health measures, sometimes also revealing important data on health etiology, diagnosis and treatment.[18]

For the generation of proposals and working plans, which enable the adequate adoption of measures in clinical and public health fields, the ethnic issues related to anthropometry and body composition need to be cleared up. In view of this, the present study had as its main goal the comparison of anthropometric and body composition variables between adolescents of two distinct ethnic groups: Japanese and Caucasian. Besides, the study also verified the influence of menarche on these variables.

Methods and sample

Sampling and design of the study

A cross-sectional methodological design with incomplete sampling was used with the subject as the evaluation unit. The study was approved by the Ethics Committee of the Universidade Federal de São Paulo/Escola Paulista de Medicina and consent to the participation of the adolescents was given by the directors of the included schools.

The anthropometric and body composition measures were collected from 10- and 11-y-old premenarcheal adolescents, and 16- and 17-y-old postmenarcheal adolescents, regardless of ethnicity, who attended 15 private schools in the city of São Paulo, Brazil. The measurement of all the girls in every class was made impossible due to time constraints on occasions such as in the period preceding school holidays. All the Japanese adolescents were measured, together with an equivalent number of girls of other ethnicities. They were chosen by allocating a number to each one of them, and then drawing the numbers from a bag. An additional number of three or four Caucasian girls were also selected and measured to act as eventual substitutes.

The following selection criteria were adopted for the inclusion of adolescents in the study: (1) those of Japanese origin had to have three or four grandparents born in Japan; (2) those of Caucasoid origin had to be descended from Caucasians with no ancestors of Negroid, Asian or other ethnic origin; (3) they had to be free from health problems such as cardiac diseases, critical renal diseases, diabetes, severe infections, fractures, etc; (4) they could not habitually ingest alcoholic drinks; (5) they had to be childless. According to these criteria, 122 Japanese and 179 Caucasian, 10- to 11-y-old premenarcheal girls, and 72 Japanese and 177 Caucasian, 16- to 17-y-old postmenarcheal girls were selected. The data collected from adolescents of other ethnicities (Negro, mixed race, Caucasian Asian, etc) will be used in other studies, as the samples of these groups were insufficient for inclusion in this study.

Anthropometry and body composition

Measurements, which were taken during a gym class, took 15–20 min per subject. The height was measured to the nearest millimeter with a tape measure, affixed to the wall. A Tanita bioelectrical impedance analyzer (model TBF 521, Tanita Corporation of America, Inc., Arlington Heights, IL, USA), was used to measure simultaneously the weight and percentage of body fat. Estimation of body composition using electrical impedance equipment is based on the principle that the conduction of low-frequency electric current in fat-free mass is higher than the conduction in fat. The foot-to-foot system was employed in the present study, as it offers operational advantages over the conventional BIA method when used with large samples.[16]

Since it was not possible to weigh the adolescents only in underwear, they were weighed in their school uniform, which consisted of a T-shirt and gym-suit. The girls stood upright and barefooted on the electrodes of the analyzer, after cleaning their feet with a piece of cotton wool, soaked in alcohol; the electrodes were also cleaned before each measurement. The following criteria were adopted for body fat measurement using the Tanita equipment: (1) before the adolescents started to perform any physical activity in the gym class, weight and percent body fat were determined; (2) during the period from 1 week before menstruation to the end of menstruation, no measurements were taken from the postmenarcheal adolescents; (3) none of the adolescents were using diuretic drugs in the 12-h period preceding the measurement.

For the BMI, the cutoff point for thinness was set at the 5th percentile of the BMI distribution of the National Center for

Health Statistics (NCHS) reference population,[19] and the cutoff point for overweight and obesity was set at the 85th percentile. The risk cutoff point for low height was set at the 10th percentile of height/age index distribution of the NCHS reference population.

The relative sitting height (Rel-SH) was computed as sitting height/height $\times 100$.

The fat-free mass index (FFMI) and the body fat mass index (BFMI) were calculated from the kilograms of fat-free mass (FFM) and kilograms of fat mass (BFM), respectively. Each variable was divided by the square of the height.[20]

The NIR method was performed using the FUTREX-5000 A (Futrex, Inc., Gaithersburgs, MD, USA). This apparatus consists of a monochromatic wave emitter and a fiber optic probe, which conducts radiation from the emitter to a body-selected site (biceps) and picks up the interactive radiation.[17] Since different types of tissue absorb light at different wavelengths, the infrared light interactance works as a body composition analysis method. Thus, pure fat absorbs light at 930 nm, while water absorbs at 970 nm. Based on the below area curve that is made up of spectrophotometric parameters, percent body fat plus FFM are obtained through equations. Since it presents characteristics such as quickness, noninvasive, security and relatively low cost, the method has become widespread.

The analyzer measured the percent body fat (%FNIR) and the number of kilograms of fat, and FFM. Two measurements were taken from the biceps midline; if the measurements disagreed with each other by more than 3%, they were repeated until agreement was reached.

For the analysis of the relation between body fat and cutaneous skinfolds (%FSKI), the Slaughter equations[21] were chosen. The tricipital and subscapular cutaneous skinfolds used in the equations were measured conventionally on the right side of the adolescents using Lange skinfold calipers with a constant pressure of 10 g/mm.[22] Each measure was determined three times and the final result was the mean of the three obtained values. If one of the values disagreed with the others on more than 5% in the same site, a new series of three measures was performed.

All measurements were taken by the same person.

Statistical analysis

For the analysis of the comparison based on ethnic group according to the frequency of results, equal to or below the 10th percentile of the height/age index distribution of the NCHS reference, the χ^2 test for the 2×2 table was adopted.

The pre- and postmenarcheal groups were compared with regard to ethnicity and, then, the ethnic groups were investigated based on menarche status. For both analyses, the Student's *t*-test was used for independent samples in variables with a normal distribution, namely weight, height and sitting height. For all the anthropometric and body composition variables, except weight, height and sitting height, the Mann–Whitney test for independent skewed distribution variables[23] was adopted. The level of statistical significance was set at 5% ($P \leq 0.05$) for all the tests.

Results

The frequency of Japanese and Caucasian pre- and postmenarcheal adolescents, below the 10th percentile of the height/age (H/A) index distribution of the NCHS reference population, is presented in Table 1. No statistically significant difference between Japanese and Caucasian adolescents could be verified concerning the prevalence of low height among the premenarcheal girls. However, the mean values for height were significantly lower in the Japanese group (Table 2).

The frequency of individuals below the 10th percentile was significantly higher within the Japanese group when compared with the Caucasian group (22.2% $\times$ 6.2%, respectively; $\chi^2 = 13.57$*, $P = 0.000$) among the postmenarcheal adolescents.

Table 2 reveals that Japanese pre- and postmenarcheal adolescents presented values of weight and height significantly lower than their Caucasian counterparts. With regard to the variable Rel-SH, the Japanese pre- and postmenarcheal groups demonstrated higher values than the Caucasian groups. Among the Japanese and Caucasian adolescents, regardless of ethnicity, the BMI did not present statistical discrepancies (Table 2).

Within both the ethnic groups studied (Table 2), the results attained based on menarche status evidenced that the anthropometric variables were statistically higher among the postmenarcheal adolescents.

The values of sitting height and Rel-SH were higher among Japanese and Caucasian postmenarcheal adolescents in relation to the premenarcheal adolescents of both ethnic groups.

The body composition variables (Table 3) indicated that the Japanese premenarcheal adolescents presented values of percent body fat (%FNIR), amount of fat (BFM) and FFM in kilograms, all obtained through the NIR, significantly lower

Table 1 Pre- and postmenarcheal adolescents based on ethnic group, according to the frequency of results equal to or below the 10th percentile of the height/age index distribution of the NCHS reference curve

	Percentile ≤ 10		
Height/age (H/A) Frequencies	*Japanese (I)* n (%)	*Caucasian (II)* n (%)	*χ2 test I × II*
Premenarcheal adolescents (A)	8 (6.6)	15 (8.4)	0.34 $P = 0.550$
Postmenarcheal adolescents (B)	16 (22.2)	11(6.2)	13.57* $P = 0.000$ I > II

Results of the χ^2 test (crit $\chi^2 = 3.84$). *Significant value

Table 2 Comparisons based on menarche status and ethnicity of Japanese and Caucasian adolescents, anthropometry results

	Premenarcheal adolescents				*Postmenarcheal adolescents*			
	Japanese (N = *122*)		*Caucasian* (N = *179*)		*Japanese* (N = *72*)		*Caucasian* (N = *177*)	
Anthropometria	$\bar{X} \pm s.d.$	*Median*	$\bar{X} \pm s.d.$	*Median*	$\bar{X} \pm s.d.$	*Median*	$\bar{X} \pm s.d.$	Median
Weight	$37.8 \pm 7.6^{a,b}$	36.4	41.3 ± 10.3^{c}	39.5	53.7 ± 7.8^{c}	52.9	57.9 ± 8.5	57.1
Height	$143.4 \pm 5.7^{a,b}$	142.5	147.0 ± 7.5^{c}	146.2	158.1 ± 4.5^{c}	158.2	162.9 ± 6.0	162.7
Sitting height	75.6 ± 3.2^{b}	75.3	76.0 ± 4.0^{c}	75.6	85.0 ± 2.7	84.5	85.6 ± 3.0	85.5
Rel-SH	$52.7 \pm 1.1^{a,b}$	52.7	51.7 ± 1.2^{c}	51.7	53.7 ± 1.1^{c}	53.6	52.5 ± 1.2	52.5
BMI	18.3 ± 3.1^{b}	17.6	18.9 ± 3.4^{c}	18.0	21.4 ± 2.8	20.8	21.8 ± 2.9	21.5

Mean ($\bar{X}$), standard deviation (s.d.) and median values. Results of Student's *t*-test (critical $t = 1.97$) for weight, height and sitting height and of the Mann–Whitney test (critical $z = 1.96$) for Rel-SH and BMI. Significant *P*-values at the 0.05 level. Rel-SH: relative sitting height; BMI: body mass index.
[a]Significantly different from Caucasian premenarcheal adolescents.
[b]Significantly different from Japanese postmenarcheal adolescents.
[c]Significantly different from Caucasian postmenarcheal adolescents.

Table 3 Comparisons based on menarche status and ethnicity of Japanese and Caucasian adolescents, body composition results

	Premenarcheal adolescents				*Postmenarcheal adolescents*			
	Japanese (N = *122*)		*Caucasian* (N = *179*)		*Japanese* (N = *72*)		*Caucasian* (N = *177*)	
Anthropometry	$\bar{X} \pm s.d.$	Median	$\bar{X} \pm s.d.$	Median	$\bar{X} \pm s.d.$	*Median*	$\bar{X} \pm s.d.$	Median
%FNIR	$19.9 \pm 4.7^{a,b}$	18.3	21.4 ± 5.3^{c}	20.2	30.1 ± 5.0^{c}	30.6	29.1 ± 4.6	28.6
Body fat mass (BFM)	$7.9 \pm 3.4^{a,b}$	7.0	9.3 ± 4.5^{c}	8.0	16.4 ± 4.8	16.2	17.1 ± 5.1	16.3
Fat-free mass (FFM)	$29.9 \pm 4.6^{a,b}$	29.5	32.0 ± 6.0^{c}	31.6	37.2 ± 3.7^{c}	37.4	40.7 ± 4.3	40.7
Body fat mass index (BFMI)	3.8 ± 1.6^{b}	3.4	4.2 ± 1.8^{c}	3.7	6.6 ± 1.9	6.3	6.4 ± 1.9	6.1
Fat-free mass index (FFMI)	14.5 ± 1.8^{b}	14.5	14.7 ± 1.8^{c}	14.5	14.9 ± 1.1^{c}	14.8	15.3 ± 1.2	15.3
%FBIA	26.4 ± 6.1^{b}	25.5	27.3 ± 6.6^{c}	26.0	31.8 ± 5.0	31.0	32.2 ± 6.4	32.0
%FSKI	24.9 ± 8.5^{b}	23.6	24.6 ± 8.9^{c}	23.5	32.4 ± 6.3^{c}	32.9	30.1 ± 6.6	29.9

Mean ($\bar{X}$), standard deviation (s.d.) and median values. Results of Mann–Whitney test (critical $z = 1.96$). Significant *P*-values at the 0.05 level. %FNIR: percentage of fat through the near-infrared interactance (NIR); %FBIA: percentage of fat through the BIA; %FSKI: percentage of fat through the skinfolds.
[a]Significantly different from Caucasian premenarcheal adolescents.
[b]Significantly different from Japanese postmenarcheal adolescents.
[c]Significantly different from Caucasian postmenarcheal adolescents.

than those of Caucasian adolescents. The Japanese girls presented a bias toward a lower BFMI in comparison with the Caucasian group, although no significant difference could be encountered regarding the FFMI.

Concerning the postmenarcheal adolescents, the mean of percent body fat, with the exception of the percentage of fat through the BIA (%FBIA), was higher in the Japanese group than in the Caucasian one (Table 3). Nevertheless, only the percent body fat through the SKI (%FSKI) was statistically different between the groups. The FFM mass was significantly lower among the Japanese girls. The FFMI was also statistically lower; however, the BFMI did not reveal statistically significant differences between the two ethnic groups.

The analysis based on menarche status demonstrated that all the body-composition-related variables were statistically higher in the postmenarcheal girls for both the groups assessed (Table 3).

Discussion

Different results of weight and height between the Japanese and Caucasian adolescents may bring back the discussion concerning separate growth curves for different ethnic groups. The presence of distinct genetic potentials for the various ethnic groups comprised in a population submitted to the same socioeconomic conditions is undeniable, despite the existing criticism with regard to the development of separate growth curves.

The height means encountered for the Japanese pre- and postmenarcheal girls of the present study were lower than the height medians presented by the high-income sample of

the 'Pesquisa Nacional sobre Saúde e Nutrição' (National Research on Health and Nutrition), conducted in Brazil in 1989.[24] On the contrary, the height values of the Caucasian girls were slightly higher than those of that sample. The frequency of individuals below the 10th percentile of the height/age (*H*/*A*) index distribution of the NCHS reference population was significantly higher within the Japanese group when compared with the Caucasian group. The statistically higher number of Japanese postmenarcheal adolescents below the cutoff point considered as a risk for low height raises the issue of whether these deficits were real, or only denoted an inadequacy of the reference standard to the ethnic group studied. Based upon the suitable socioeconomic background of these adolescents, it is a plausible argument that this international growth curve may be generating an overestimation of early malnutrition levels within this group.

The study was not carried out with the intention to represent the quantitative Japanese adolescent population of Sao Paulo. The data in Table 1 only analyze the level of individuals below the 10th percentile of the NCHS index distribution for a better view of the difference in growth.

In the Caucasian group, it is likely that the greater standard deviation in stature and weight results (Table 2) can be associated to a greater maturation status variation; this was subsequently discussed in detail. Moreover, the heterogeneity of the Brazilian population did not permit a better characterization of the Caucasian group, verifying that there are differences in distinct Caucasian groups. For example, the Latin people, such as those of Portugal or Spain, are very different from the German or English people. There are also diverse racial combinations in Brazil, which probably affect the variable anthropometrics, making the Caucasian group more vulnerable to the variations. Nevertheless, the *t*-test used considers the difference in the variances between the groups, reducing the effect of this bias.

With reference to the Rel-SH, the figures of this study are in agreement with other investigations.[7,25–27] Some studies have demonstrated that individuals of the Asian groups present an increased Rel-SH when compared with their Caucasian counterparts.[7,14,15] Several studies have suggested that differences in trunk/limb proportion may lead to a variation in the relation between the BMI and percent body fat.[12,14,15] Suggestions have been made by a few authors that environmental factors may have caused the proportional discrepancies between European and Japanese groups, perhaps in association with socioeconomic features.[5,7] However, on comparing trunk/limb proportions of individuals from various ethnic groups, Martorell *et al*[26] verified that a low socioeconomic status was correlated negatively with length measures (height, sitting height and length of the legs), but was not connected with relative proportions (Rel-SH). Considering that the groups of this study belonged to similar socioeconomic strata, the differences found regarding this variable could be due to distinct genetic potentials.

Premenarcheal girls presented a lower Rel-SH in comparison with the postmenarcheal adolescents. The cross-sectional analysis conducted by Forbes (1992),[28] of various measures of girls whose menarcheal ages were known, also revealed an increase in the relative sitting height (%).

BMI mean values of the Japanese and Caucasian pre- and postmenarcheal groups, according to the present study, were similar to the BMI mean values attained in the distribution performed by Rosner *et al*.[29] However, evidence is present that the relation between the BMI and the percent body fat may be different in these ethnic groups.

The %FBIA means of the present study were similar to the values of percent body fat provided by dual-energy X-ray absorptiometry (DEXA) for premenarcheal girls in the study of Barros.[11]

Values of %FNIR were lower than the percent body fat values encountered by the two other methods in premenarcheal girls. These results were in agreement with the preliminary study performed with the partial sample of the adolescents.[30] Diverse methods of body composition assessment (BMI, BIA, NIR, SKI) between these two ethnic groups were compared by Sampei *et al*[30] in this study, beyond verifying differences between the pre- and postmenarcheal groups. An adequate concordance of the NIR with the other methods was revealed in the study; yet a bias toward the underestimation of body fat levels was presented by the NIR, mainly among premenarcheal girls on the other hand, generating conclusions that had similarly been drawn in other studies in the literature.[31–35] Conversely, the BIA values were higher than those of the other methods; however, regarding nutritional status, the authors concluded that the higher values encountered do not radically change the adolescents' picture.

It is necessary to emphasize that an evaluation method analysis of body fat was conducted in a previous study, while differences in anthropometric and body composition variables of the groups are focused on in the present study, taking ethnicity and sexual maturation into consideration. In this study we chose to maintain all percent fat measures, which were in the first study for the following reasons: (1) since none of the methods used is considered a gold standard, a choice could not be made as to which method would be the best in presenting the results; (2) in the analysis of the results one method can complement the analysis of the other by giving a more general view of the variables.

An eventual difference in the maturation status between the groups would be one of the possible explanations, mainly regarding the %FNIR and BFM, for the different results between the ethnic premenarcheal groups assessed. Since the project planning verified the impossibility of adopting the boards of sexual maturation, as proposed by Tanner, in all the schools, a deeper evaluation of the sexual maturation status was not possible in the present study. Thus, only menarche was taken into account, once it

represents a marked event with characteristics that enable the definition of distinct groups concerning sexual maturation. Furthermore, some authors have indicated that the self-observation techniques of pubertal development following Tanner's standardization may be liable to errors.[36] Owing to the existence of ethnic differences that compromise the definition of the adolescents' sexual maturation stage,[37,38] other studies have recommended caution on the classification of pubertal development.

Among premenarcheal adolescents, it is well known that some girls belong to more advanced sexual maturation stages than others and, hence, may present higher values for some anthropometric and body composition variables. A certain imprecision regarding the values of the studied variables in the present study was due to the lack of information on the sexual maturation stages. However, one can suggest that this deficiency has not considerably compromised the interpretation of the results.

The %FNIR and BFM results of the Japanese postmenarcheal adolescents were slightly higher than the values encountered by Priore[39] in a study of body composition and eating habits, in 16- to 18-y-old adolescents from public schools in São Paulo. The Caucasian adolescents' FFM values were similar to the values found in that study; however, the results of the Japanese group were lower, indicating that the Japanese adolescents presented different characteristics from the sample evaluated by Priore.[39]

Barros[11] verified that the percent body fat mean provided by DEXA in girls whose menarche had dated from more than 2 y corresponded to 30%. This value was similar to the percent body fat values obtained through NIR, BIA and SKI among the postmenarcheal adolescents in the present study.

Corroborating the results of the present study, several investigations have demonstrated that, for an identical value of BMI, the percent body fat in Asians was higher than in Caucasian individuals.[2,3,13–15]

The variations in the body build and sitting height[2,13–15] could be a reason for the differences in the relation between the BMI and percent fat. Individuals with a smaller body build would not only have less bone mass to the same body height, but probably less muscle mass and connective tissue as well. Thus, the height-normalized indices of fat and fat-free mass (BFMI and FFMI) would be recommended, once they avoid ambiguities frequently generated when these components are reported as percentages of body weight and/or absolute weight.[20] These indices pointed to a lower amount of FFM in the Japanese postmenarcheal group.

As various studies have demonstrated that the nutritional indicators of postmenarcheal groups are higher than those of adolescents who have not yet experienced menarche,[40–44] the higher values for the anthropometric and body composition variable of the postmenarcheal adolescents were not surprising. The maximum growth speed in height and body mass takes place around 6 months to 1 y prior to menarche, and is a well-known fact. The increase of weight after menarche is a consequence of a general body growth, and mainly due to an increase in fat deposits derived from a greater action of estrogen and progesterone.

In the present study, the mean BMI values were found to be within the range of eutrophy in postmenarcheal adolescents of both ethnic groups. Nevertheless, the percent body fat values determined by other methods of body composition assessment were quite high. This result was tackled in the preliminary study, in which Sampei *et al*[30] concluded that among the premenarcheal girls, regardless of the ethnic group, the BMI in the 85th percentile might be used in substitution for other methods, yet taking into account that sometimes the BMI might underestimate obesity. On the other hand, among the Japanese and Caucasian postmenarcheal adolescents, the BMI of the 85th percentile is probably not a suitable index for the identification of obesity, as a high percent body fat level was encountered in adolescents with BMI ranges considered normal.

Owing to the heterogeneity of the population in Brazil, it is worth pointing out that the inclusion of ethnicity as a variable has become almost indispensable, in order to minimize its confounding effect on the analysis, and conclusion of various studies to be carried out on anthropometry and body composition.

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References

1 Roche AF, McKigney JI. Physical growth of ethnic groups comprising the US population. *Am J Dis Child* 1976; **130**: 62–64.
2 Wang J, Thornton JC, Russel M, Burastero S, Heymsfield S. Asians have lower body mass index (BMI) but higher percent body fat than do Caucasians: comparisons of anthropometric measurements. *Am J Clin Nutr* 1994; **60**: 23–28.
3 Potts J, Simmons D. Sex and ethnic group differences in fat distribution in young United Kingdom South Asians and Europids. *J Clin Epidemiol* 1994; **47**: 837–841.
4 Malina RM, Huang Y-C, Brown KH. Subcutaneous adipose tissue distribution in adolescent girls of four ethnic groups. *Int J Obes Relat Metab Disord* 1995; **19**: 793–797.
5 Greulich WW. Some secular changes in the growth of American-born and native Japanese children. *Am J Phys Anthropol* 1976; **45**: 553–568.
6 Matsumoto K. Secular acceleration of growth in height in Japanese and its social background. *Ann Hum Biol* 1982; **9**: 399–410.

7 Tanner JM, Hayashi MA, Preece MA, Cameron N. Increase in length of leg relative to trunk in Japanese children and adults from 1957 to 1977: comparison with British and with Japanese Americans. *Ann Hum Biol* 1982; **9**: 411–423.
8 Kac G, Santos RV. Crescimento físico em estatura de escolares de ascendência japonesa na cidade de São Paulo, Brasil. *Cad Saúde Publ* 1996; **12**: 253–257.
9 Gallangher D, Marjolein V, Sepúlveda D, Pierson RN, Harris T, Heymsfield SB. How useful is body mass index for comparison of body fatness across age, sex, and ethnic groups? *Am J Epidemiol* 1996; **143**: 228–39.
10 Ellis KJ, Abrams AS, Wong WW. Monitoring childhood obesity: assessment of weight/height^2 index. *Am J Epidemiol* 1999; **150**: 939–946.
11 Barros ME. *Composição corporal de adolescentes de bom nível sócio-econômico: determinação pelo método da absorção do duplo feixe de energia (DEXA)*. São Paulo, 1999. [Tese de Mestrado — Universidade Federal de São Paulo-Escola Paulista de Medicina].
12 Norgan NG. Population differences in body composition in relation to the body mass index. *Eur J Clin Nutr* 1994; **48** (Suppl 3): S10–S27.
13 Gurrici S, Hartriyanti Y, Hautvast JGAJ, Deurenberg P. Relationship between body fat and body mass index: differences between Indonesians and Dutch Caucasians. *Eur J Clin Nutr* 1998; **52**: 779–783.
14 Deurenberg P, Deurenberg M, Wang J, Lin FP, Schmidt G. The impact of body build on the relationship between body mass index and percent body fat. *Int J Obes Relat Metab Disord* 1999; **23**: 537–542.
15 Deurenberg-Yap M, Schmidt G, Staveren WA van, Deurenberg P. The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. *Int J Obes Relat Metab Disord* 2000; **24**: 1011–1017.
16 Nuñez C, Gallangher D, Visser M, Pi-Sunyer FX, Wang Z, Heymsfield SB. Bioimpedance analysis: evaluation of leg-to-leg system based on pressure contact foot-pad electrodes. *Med Sci Sports Exerc* 1997; **29**: 524–531.
17 Conway JM, Norris KH, Bodwell CE. A new approach for the estimation of body composition: infrared interactance. *Am J Clin Nutr* 1984; **40**: 1123–1130.
18 Senior PA, Bhopal R. Ethnicity as variable in epidemiological research. *BMJ* 1994; **309**: 327–330.
19 Himes JH, Dietz WH. Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. *Am J Clin Nutr* 1994; **59**: 307–316.
20 VanItalie TB, Yang UM, Heymsfield SB, Funk RC, Boileau RA. Height-normalized indices of the body's fat-free mass and fat mass: potentially useful indicators of nutritional status. *Am J Clin Nutr* 1990; **52**: 953–959.
21 Slaughter MH, Lohman TG, Boileau CA, Horswill CA, Stillman RJ, Van Loan MD, Bemben DA. Skinfold equations for estimations of body fatness in children and youth. *Hum Biol* 1988; **60**: 709–723.
22 Durnin JVGA, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. *Br J Nutr* 1974; **32**: 77–97.
23 Siegel S. *Nonparametric statistics for behavioral sciences*. McGraw-Hill: New York, 1956.
24 INAN (Instituto Nacional de Alimentação e Nutrição). *Pesquisa Nacional sobre Saúde e Nutrição. Perfil de Crescimento da População Brasileira de 0 a 25 anos*. INAN: Brasília; 1990.
25 Leung SSF, Lau JTF, Xu YY, Tse LY, Huen KF, Wong GWK, Law WY, Yeung VTF, Yeung WKY, Yeung NK. Secular changes in standing height, sitting height and sexual maturation of Chinese — the Hong Kong growth study, 1993. *Ann Hum Biol* 1996; **23**: 297–306.
26 Martorell R, Malina RM, Castillo RO, Mendoza FS, Pawson IG. Body proportion in three ethnic groups: children and youths 2–17 year in NHANES II and HHANES. *Hum Biol* 1988; **60**: 205–222.
27 Hojo T, Nakashima T, Hirao T. Stature, sitting height and relative sitting height of female northern Kyushuites. *Sangyo Ika Daigaku Zasshi* 1984; **6**: 355–357.
28 Forbes GB. Body size and composition of perimenarchal girls. *Am J Dis Child* 1992; **146**: 63–66.
29 Rosner B, Prineas R, Loggie J, Daniels SR. Percentiles for body mass index in U.S. children 5 to 17 year of age. *J Pediatr* 1998; **132**: 211–222.
30 Sampei MA, Novo NF, Juliano Y, Sigulem DM. Comparison of the body mass index to other methods of body fat evaluation in ethnic Japanese and Caucasoid adolescent girls. *Int J Obes Relat Metab Disord* 2001; **25**: 400–408.
31 Mclean KP, Skinner JS. Validity of Futrex-5000 for body composition determination. *Med Sci Sports Exerc* 1992; **24**: 253–258.
32 Elia M, Parkinson AS, Diaz E. Evaluation of near infrared interactance as a method for predicting body composition. *Eur J Clin Nutr* 1990; **44**: 113–121.
33 Thomas DW, Ryde SJ, Ali PA, Birks JL, Evans CJ, Saunders NH, Al Zeibak S, Dutton J, Hancock DA. The performance of an infra-red interactance instrument for assessing total body fat. *Physiol Meas* 1997; **18**: 305–315.
34 Wilmore KM, McBride PJ, Wilmore JH. Comparison of bioelectric impedance and near-infrared interactance for composition assessment in a population of self-perceived overweight adults. *Int J Obes Relat Metab Disord* 1994; **18**: 375–381.
35 Vehrs P, Morrow Jr JR, Butte N. Reliability and concurrent validity of FUTREX and bioelectrical impedance. *Int J Sports Med* 1998; **19**: 560–566.
36 Guimarães JP, Passos ADC. Análise de concordância entre informações referidas e observadas acerca do estadiamento pubertário entre escolares do sexo feminino. *Rev Saúde Pública* 1997; **31**: 263–271.
37 Herman-Giddens ME, Slora EJ, Wasserman RC, Bourdony CJ, Bhapkar MV, Koch GG, Hasemeier CM. Secondary sexual characteristics and menses in young girls seen in office practice: a study from the pediatric research in office settings network. *Pediatrics* 1997; **99**: 505–512.
38 Graham EA, Sugar N. Secondary sexual characteristics and menses in young girls. *Pediatrics* 1998; **101**: 946 (letter).
39 Priore SE. *Composição corporal e hábitos alimentaes de adolescentes: uma contribuição à interpretação de indicadores do estado nutricional*. São Paulo, 1998 [Tese de Mestrado—Universidade Federal de São Paulo-Escola Paulista de Medicina].
40 Duarte MF. A influência da menarca na aptidão física de escolares. In: *Congresso brasileiro de medicina desportiva*, 8, Rio de Janeiro. Anais, Rio de Janeiro, 1987, V.1, p 16.
41 George IMS, WilliamS S, Silva PA. Body size and the menarche: the Dunedin Study. *J Adolesc Health* 1994; **15**: 573–576.
42 Porcu E, Venturolii S, Fabbri R, Paradisi R, Longhi M, Sganga E, Flamigni C. Skeletal maturation and hormonal levels after menarche. *Arch Gynecol Obstet* 1994; **255**: 43–46.
43 Goldberg TBL, Colli AS, Curi PR. Relação entre área do braço, área do músculo, área de gordura do braço e a menarca em adolescentes do município de Botucatu. *J Pediatr* (Rio J) 1996; **72**: 85–92.
44 Magarey AM, Boulton TJC, Chatterton BE, Schultz C, Nordin BEC, Cockington RA. Bone growth from 11 to 17 years: relationship to growth, gender and changes with pubertal status including timing of menarche. *Acta Paediatr* 1999; **88**: 139–146.