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Diagnosing the nutritional status of schoolchildren: a comparison between Brazilian and international criteria

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Abstract

Objective: To compare Brazilian and international criteria for assessing the nutritional status of schoolchildren.

Methods: This was a cross-sectional study that enrolled 160 schoolchildren from a public school in the city of Rio de Janeiro, 91 boys and 69 girls, aged 7 to 9 full years. Body mass index (BMI) for sex and age was used to diagnose underweight, healthy weight and overweight, according to Cole et al., Conde & Monteiro and the World Health Organization (WHO) criteria. Student's *t* test, the chi-square test, the Kendall concordance test and the chi-square test for tendencies were used to analyze the data; graphs were plotted demonstrating BMI by age, according to the nutritional diagnosis at each set of criteria.

Results: Mean BMI did not differ by sex ($t = 0.2845$, $p = 0.7789$). According to the first two sets of criteria, none of the children were underweight, whereas, according to the WHO criteria, one of the boys was underweight. The Kendall test did not demonstrate any significant difference between the three sets of criteria (coefficient of concordance for boys was $W < 0.0004$ and for girls it was $W < 0.0008$, with $p = 1.00$). There was a greater proportion of assessments that did not agree among the boys, at 15.13%, while for the girls this figure was 13.04%. A significant tendency was observed for the difference between the criteria to increase with age among the boys (chi-square for tendencies = 6.552, $p = 0.0105$), which was evident on the graph and was independent of nutritional status.

Conclusions: The criteria used here converged on the same result, without discrepancies between them or advantages for either. Nevertheless, among the boys there was a significant tendency for the diagnoses to differentiate and BMI to increase with age, which is a warning to take care when choosing among criteria.

J Pediatr (Rio J). 2008;84(6):550-555: Nutritional assessment, nutritional status, diagnostic methods, body mass index, children.

Introduction

Monitoring nutritional status is important at all ages and is a central axis of healthcare actions aimed at childhood and adolescence. Its importance during these phases of life stems from monitoring the process of growth and development, in order to detect possible health problems and risks of morbidity and mortality,[1,2] especially with reference to the prevalence of overweight/obesity in Brazil and worldwide.[3-5]

Until recently, the nutritional status of Brazilian children was assessed using the indicators weight/height and height/

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age, in accordance with World Health Organization (WHO) recommendations.[6] Over recent decades, different assessment criteria have emerged, and body mass index (BMI), obtained from national studies using distinct methodologies and populations, has been proposed as an indicator.[7-11]

Cole et al.[8] developed proposals based on national studies carried out in several countries, including the United States, England, Singapore, Hong Kong and Brazil. This nutritional assessment system was recommended by the International Obesity Taskforce for assessment of overweight and obesity in children and adolescents. Later on, the same authors supplemented that research, publishing figures for diagnosing underweight and, consequently, making it possible to determine healthy weight as well.[9] Within the same area of research, Conde & Monteiro[10] recently published a proposal in Brazil presenting new criteria for nutritional assessment of children and adolescents, adopting the same indicator, calculated from anthropometric measurements obtained from a study carried out with the Brazilian population.

In 2007, Onis et al.[11] published a new reference standard for nutritional assessment of children and adolescents using BMI, based on the WHO[12] data from the American population.

This diversity of proposals calls attention to the possibility that different results may be obtained depending on which method is used. Within this context, this study was conducted with the objective of assessing the nutritional status of schoolchildren using three different sets of criteria and of comparing the resulting diagnoses. The criteria chosen were those proposed by Cole et al.,[8,9] Conde & Monteiro[10] and the WHO.[12]

Methods

This is a cross-sectional epidemiological study which is the first stage of a larger longitudinal research project with schoolchildren. The underlying project was planned as a cohort study focusing on adolescence, including an initial census phase to establish the nutritional profile of all of the schoolchildren (children and adolescents). In 2007, 1,004 students were enrolled at the school. From this total, 199 schoolchildren (19.82%) were lost to the sample. Of these, 76 did not take part because they were in their pre-university year and 123 did not agree to participate. Therefore, the research project included 805 schoolchildren, predominantly adolescents, breaking down into 645 adolescents aged 10 to 19 full years and 160 children aged 7 to 9 years. The population of 160 children aged from 7 to 9 full years was made up of 91 boys and 69 girls. The study variables were: sex, age (years), weight (kg and g), height (cm), BMI (kg/m^2) and classification of nutritional status.

Nutritional status was assessed according to age and sex, using BMI with cutoff points defined for underweight, healthy weight and overweight, according to the three proposed sets of criteria.

In order to obtain the full range of criteria proposed by Cole et al.,[8,9] the two publications, from 2000[8] and 2007,[9] were combined. The BMI figures for underweight were taken from the 17 kg/m^2 column in the 2007 Cole et al. study.[9] Healthy weight was defined as the BMI values between the 2007, 17 kg/m^2 column,[9] and the 2000, 24.9 kg/m^2 column.[8] Overweight was defined based on the 2000 publication,[8] taking the 25 kg/m^2 BMI figures as the cutoff. The cutoff values in the BMI/sex/age columns that were used here can be found in the tables published in the two studies cited.[8,9]

The criteria published by Conde & Monteiro[10] defines BMI cutoffs for both underweight and overweight. For the purposes of this study, we defined the interval between the BMI values for underweight (inclusive) and those for overweight (exclusive) as the healthy weight. These values have been published in detail in tabulated format.[10]

The WHO cutoffs were taken from the scale of percentiles on the simplified table published by the WHO,[12] based on a study carried out by Onis et al.[11] Underweight was defined as BMI values below the 3rd percentile; healthy weight as those between the 3rd percentile (inclusive) and the 85th percentile (exclusive); and overweight was defined as BMI at or above the 85th percentile.

Body measurements were taken according to standards defined by Lohman et al.[13] by trained anthropometrists, including undergraduate Nutrition students and graduate students studying healthcare, with the objective of guaranteeing precision and exactness.

Body weight was measured using a portable digital balance, SECA® brand, with the capacity for 150 kg. Height was measured using a 2m stadiometer fixed to a wall with no skirting. Children were measured in the orthostatic position, positioned in such a way that the head, shoulders, buttocks and calves touched the smooth wall. Height was measured in duplicate, recorded in cm and the arithmetic mean of the two used for analysis, with a maximum of 0.1 cm allowed between the two measurements. In the rare cases in which this value was exceeded, the researcher chosed the measurement chosen as standard. The children were weighed unshod and with light clothing.

Data were analyzed by the following comparisons: mean BMI was compared between sexes using Student's *t* test; the prevalence rates of each nutritional status diagnosis were compared by applying the chi-square test; and the nutritional classifications made with each criteria, organized ordinally, were compared using Kendall's rank correlation test. The chi-square test for linear tendencies was employed to assess the frequencies of agreement and disagreement between the criteria according to age and sex. The significance level was defined as $p < 0.05$ for all tests. Graphs were plotted of median

Table 1 - Statistical parameters for age, weight, height and BMI, by sex

	Statistical parameters					
Variables	**Mean ± SD**	**Median**	**1st quartile**	**3rd quartile**	**Minimum**	**Maximum**
Boys (n = 91)						
Weight	32.17±7.71	30.20	26.60	36.90	21.40	56.80
Height (stature)	131.54±7.49	131.70	126.45	135.97	117.00	151.90
BMI*	18.40±3.09	18.03	16.15	19.89	13.68	28.37
Girls (n = 69)						
Weight	31.75±7.98	31.00	25.40	36.80	20.80	60.80
Height (stature)	130.10±7.77	130.35	124.30	135.20	115.40	152.80
BMI*	18.54±3.16	17.87	16.44	20.50	13.32	29.18

SD = standard deviation; BMI = body mass index.
* t = 0.284 and p = 0.778 (not significant).

BMI according to nutritional status, age and sex for each reference used. For the purposes of the chi-square test and for plotting the curves, the nutritional condition of underweight was combined with the healthy weight sample due to the very low prevalence of underweight children. This group was called "not overweight." The statistical program employed was Epi Info version 3.3.2.[14]

The project was approved without reservations by the Ethics Commission at the Universidade do Estado do Rio de Janeiro, under research protocol number 043.3.2006.

Results

Mean BMI did not differ significantly between the boys and girls with t = 0.284 and p = 0.778 (Table 1).

Neither the criteria proposed by Conde & Monteiro[10] nor by Cole et al.,[9] classified any of the children, of either sex, as underweight. The WHO criteria,[12] in contrast, identified 1 case among the boys. For the whole sample, the prevalence rates of each nutritional status diagnosis did not differ significantly between the different assessment criteria ($p > 0.05$) (Table 2).

In agreement with this result, the analysis of concordance using the Kendall rank correlation test also did not demonstrate any significant difference (coefficient of concordance for boys = $W < 0.0004$, and for girls = $W < 0.0008$, with p = 1.00).

There were 23 cases in which the three criteria did not agree, predominantly among the boys, with 15.13% of that subset, while 13.04% of the girls were classified differently by different criteria (Table 3).

Analysis of the frequencies of agreement and disagreement observed demonstrated that the number of different

Table 2 - Nutritional status diagnoses of the children, by sex, according to each of the criteria studied

Nutritional status*	**Cole et al.[8,9]**	**Conde & Monteiro[10]**	**WHO[12]**
Boys (n = 91)†			
Underweight	-	-	01
Healthy weight	57	53	43
Overweight	34	38	47
Girls (n = 69)‡			
Underweight	-	-	-
Healthy weight	40	32	33
Overweight	29	37	36

WHO = World Health Organization.
* Underweight was combined with healthy weight for the chi-square test.
† Chi-square = 3.96 and p = 0.265.
‡ Chi-square = 2.60 and p = 0.437.

Table 3 - Frequencies of agreement and disagreement between the nutritional diagnoses by each criteria, by sex and age

	Boys*			Girls†		
Age (years)	**n**	**Agreement**	**Disagreement**	**n**	**Agreement**	**Disagreement**
7	35	33	2	25	22	3
8	29	25	4	24	22	2
9	27	19	8	20	16	4
Total	91	77	14	69	60	9

* Chi-square test for linear tendencies = 6.552 and p = 0.010 (significant).
† Chi-square test for linear tendencies = 0.539 and p = 0.462 (not significant).

classifications tended to increase significantly in line with age, although only among the boys (chi-square test for tendencies = 6.552 and p = 0.01). In line with this tendency to diagnose the boys differently, Figure 1 illustrates the median BMI values in the form of lines on a graph against age. The lines diverging with age, both in the "not overweight" group and in the "overweight" group, demonstrate the differences, especially with relation to the WHO criteria.[12]

Discussion

There is not yet consensus on which proposal for nutritional assessment criteria is most appropriate for use with schoolchildren. Discussions continue both on the reference values and the cutoff point that should be used.[15-18]

In a study by O'Neill et al.,[19] with 596 Irish children aged 5 to 12 years, the authors observed an elevated prevalence

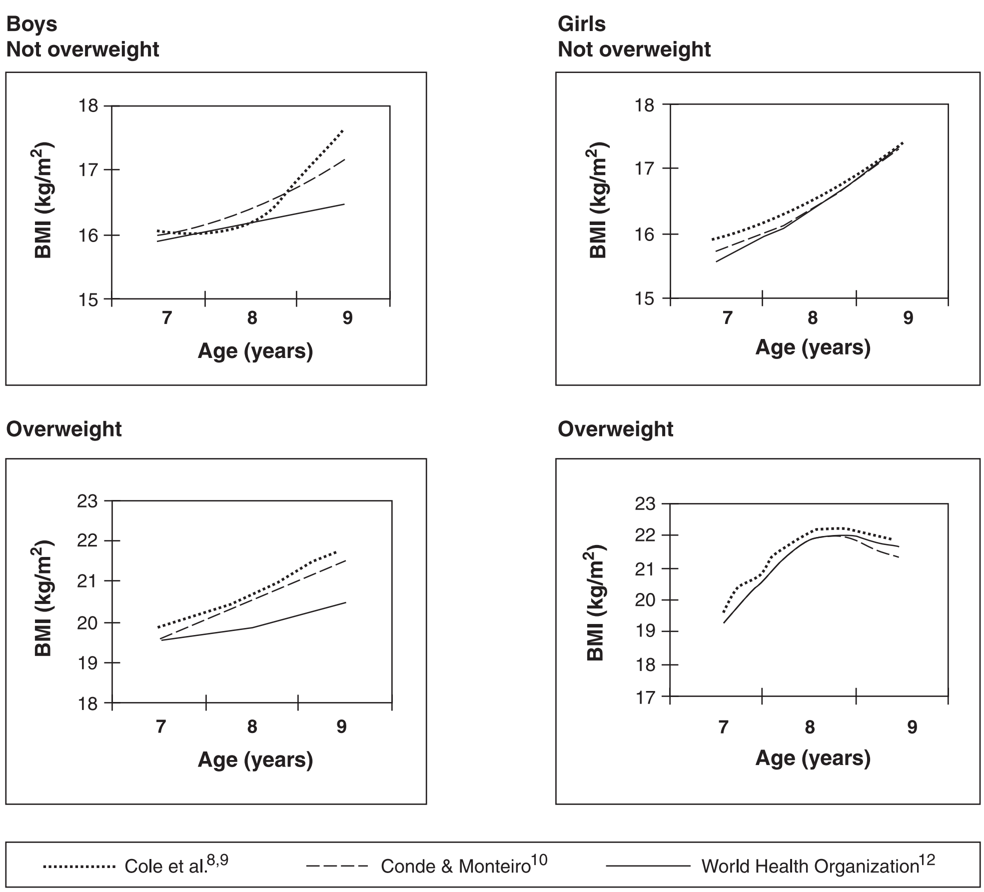

Figure 1 - Median body mass index (BMI) of children classed as overweight or not overweight by each set of criteria, by sex

of obesity/overweight in the entire group, using methods recommended by the Center of Disease Control[7] a growth curve for the United Kingdom[20] and the International Obesity Taskforce criteria.[8]

Abrantes et al.,[21] used methods proposed by Cole et al.[8] and by Must et al.[22] and performed comparative analyses with 5,736 Brazilian children and adolescents and concluded that the correlation between the two methods was satisfactory.

In a similar manner, our study did not detect significant differences in the prevalence rates of the different nutritional diagnoses of the schoolchildren, comparing proposals published by Cole et al.,[8,9] Conde & Monteiro[10] and the WHO,[12] whether for the nutritional condition of healthy weight or for overweight.

However, a study carried out by Wang & Wang[17] which used the criteria proposed by Cole et al.[8] and Must et al.[22] only observed similar results for overweight in children and adolescents, leading to the conclusion that greater care must be taken when choosing a method specifically for assessing obesity.

According to Chinn & Rona,[23] who compared the criteria proposed by Cole et al.[8] and Cole et al.[20] to assess overweight/obesity in 6,000 English children aged 4 to 11 years, the increase in the prevalence of obesity in the population during the 10 year interval may be the result of the different cutoff points proposed. For these authors, using the United Kingdom criteria,[20] the prevalence of overweight/obesity increased, with a variation of more than 7%.

Sex and age are also important elements in comparative studies of criteria for nutritional assessment, especially during the late phases of childhood and during adolescence. In this study, although there was not a statistically significant difference in the diagnoses using the three criteria, it was observed that the proportion of disagreement increased systematically with age among the boys. A similar result in terms of differentiation between age and sex was demonstrated in a study by Flegal et al.,[24] who also compared methods for nutritional assessment of children with overweight. These authors observed that, among the boys, the differences between the criteria emerged as age increased.

In a study by Marrodán et al.[25] in which two different sets of criteria were used for nutritional assessment of 7,228 children and adolescents aged from 6 to 20 years, differences were also observed to emerge as the age of the boys progressed. These authors concluded that the number of obesity cases may be underestimated and the number of overweight children overestimated, depending on the criteria adopted.

In addition to the question of the possible differences between cutoff values for different criteria, there is also a discussion about the use of BMI at the end of childhood and during adolescence. Although this nutritional indicator is widely used with adults, academics suggest caution when applying it to younger populations.[26,27] This argument is based on the variations in body composition that take place during this period of life, particularly with relation to height, which influences BMI.[26,28]

It is known that during the process of growth and development there is very significant growth in height. This, however, differs with age and sex, happening earlier among females.[28] Therefore, it would be the girls and not the boys that would have a greater biological probability of undergoing changes as a result of prepubescent phase. However, the absence of significant differences in mean BMI between sexes demonstrates that the two groups were similar. Therefore, the tendency for the different criteria to produce different nutritional diagnoses for the boys may well be a result of distinctions within the criteria themselves.

A larger sample per age group and the application of methods considered as reference standards for nutritional assessment with this age group would make it possible to make a more in-depth analysis of this tendency towards differentiation. In this study, the sample was defined by census, stratified by sex and then by age, contributing to dilutions of the sample size at each age. The small number of observations restricts the possibilities of combinations between criteria, which increases the probability that the tendency may have emerged by chance. Greater probability of identifying statistically significant differences is related to the sample size calculation and the error types (I and II) adopted for this calculation.[29]

Based on the results and the issues explored here, it is concluded that these criteria do not differ substantially in the nutritional assessment of schoolchildren. This statement, however, is made in the absence of studies to analyze the age-related differences between sexes in greater detail.

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