Anthropometric nutritional of adolescents from a region of low economic development in Brazil: comparison with the WHO-2007 reference

Antropometria nutricional de adolescentes de uma região brasileira de baixo desenvolvimento econômico: comparação com referência OMS-2007

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Abstract – The identification of nutritional inadequacies in specific segments of the youth population can provide the basis for public health intervention. The objective of this study was to evaluate anthropometric indicators of nutritional status in a sample of adolescent schoolchildren from a region of low economic development in Brazil. The sample consisted of 1,538 subjects ranging in age from 15 to 18 years, including 1,036 girls and 502 boys. Nutritional status was assessed based on height and body mass index (BMI) and comparisons were made to the corresponding percentile distributions of the Word Health Organizations-2007 (WHO-2007) reference. The percentile distributions for height and BMI in the two genders differed significantly from the WHO-2007 reference. There was a high proportion of adolescents with short height (< 10th percentile) and indication of overweight/obesity (> 90th percentile). Therefore, although being a region of low economic growth and with one of the lowest social indicators in the country, excess body weight was an important problem associated with nutritional status. The high proportion of overweight/obesity highlights the need to implement public policies designed to promote healthy eating habits and physical activity.

Key words: Growth; Height; Nutritional status; Overweight; Obesity; Undernutrition.

Resumo – *Identificar inadequações nutricionais em segmentos específicos da população jovem pode oferecer subsídios para intervenção em saúde pública. O estudo analisou o estado nutricional antropométrico em amostra de adolescentes escolares de uma região brasileira de baixo desenvolvimento econômico. A amostra foi constituída por 1.538 sujeitos, com idades entre 15 e 18 anos, sendo 1.036 moças e 502 rapazes. O estado nutricional antropométrico foi identificado mediante medidas de estatura e cálculo do índice de massa corporal (IMC). As comparações estatísticas foram estabelecidas com base nas correspondentes distribuições de percentis da referência proposta pela Organização Mundial da Saúde-2007 (OMS-2007). Os resultados encontrados mostraram que, em ambos os sexos, as distribuições de percentis equivalentes aos valores de estatura e IMC foram estatisticamente diferentes da referência OMS-2007. Foram identificadas elevadas proporções de adolescentes com baixa estatura (< 10 Percentil) e indicação de sobrepeso/obesidade (> 90 Percentil). Portanto, mesmo sendo uma região de baixo desenvolvimento econômico e com um dos mais baixos indicadores sociais do país, o excesso de peso corporal foi um importante problema associado ao estado nutricional. A elevada proporção de sobrepeso/obesidade alerta para a necessidade de implementar políticas públicas direcionadas às práticas de alimentação saudável e atividade física.*

Palavras-chave: *Crescimento; Desnutrição; Estado nutricional; Sobrepeso; Obesidade.*

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INTRODUCTION

The association of anthropometric indicators used to identify nutritional inadequacies with health status and well-being is well documented in the literature. Evidence suggests that a growth deficit in height at an early age can affect cognitive development, favoring the occurrence of infectious-contagious diseases, limiting physical capacity[1], and increasing the risk for numerous degenerative diseases in early adulthodd[2]. On the other hand, overweight and obesity are known to be related to the development of diabetes, heart diseases, osteoarthritis and some types of cancer, among other chronic diseases[3]. Overweight or obese young people tend to present a higher incidence of problems related to self-esteem and self-concept that affect interpersonal relations[4].

Nutrition transition is a process characterized by changes in eating patterns and physical activity over time. Although affecting the general population, especially societies in developing countries, this process may differ in terms of time and intensity of occurrence depending on the epidemiological context considered. A fundamental characteristic of the process of nutrition transition is a reduction in the prevalence of height growth deficits and an increase in the frequency of overweight and obesity, called double burden of malnutrition[5]. In this respect, the identification of possible nutritional inadequacies in specific segments of the youth population may provide the basis for public health intervention programs.

Observation of the process of nutrition transition in Latin American countries, specifically Brazil, over the past decades showed an important change in the prevalence of nutritional inadequacies[6-9]. However, with some exceptions[10,11], very little is known about populations that live in regions of low economic growth in Brazil. Therefore, the objective of the present study was to evaluate the nutritional status, particularly the prevalence of height growth deficits and of overweight/obesity, in a sample of adolescent boys and girls from a region of low economic growth in Brazil.

METHODOLOGICAL PROCEDURES

A cross-sectional study was conducted on adolescents of both genders ranging in age from 15 to 18 years, who were enrolled in public and private schools in the town of Francisco Sá, Minas Gerais. Data were collected between August and October 2011 and the intervention protocols used were approved by the Ethics Committee of the State University of Montes Claros (Universidade Estadual de Montes Claros – UNIMONTES).

Francisco Sá is an imperial town founded in 1704 which is located in the northern region of the state of Minas Gerais, approximately 60 km from the border with the state of Bahia. The region is characterized by a tropical semi-arid climate. The town has a population of approximately 25,000 inhabitants and the main economic activity is subsistence agriculture. With a mean human development index (IDH) of 0.581 ($IDH_{Education}$ = 0.588; IDH_{Income} = 0.503; $IDH_{Longevity}$ = 0.652), Francisco Sá has one of

the lowest development indices compared to other cities in Brazil with a similar population density. The mean IDH-2000 of cities located in the southeastern and southern regions is 0.844 and 0.825, respectively, and the Brazilian IDH-2000 is 0.800[12]. With respect to infant mortality, another indicator classically used to evaluate the level of development of a region, available data indicate 92 deaths per 1,000 live births.

The subjects were selected for the study by inviting all students enrolled in the 8th and 9th grades of elementary school and in the 1st, 2nd and 3rd years of high school (five public schools and one private school) of the second cycle of elementary school and high school in Francisco Sa. According to data from the Statistics Sector of the Department of Education of the state of Minas Gerais, at the beginning of 2011 a total of 1,912 students were enrolled in the five school years that were the focus of the study. The following exclusion criteria were adopted: (a) lack of authorization by the parents or legal guardian; (b) absence on the day of data collection; (c) some physical problem impairing the anthropometric measurements on that occasion, and (d) chronological age < 15 years and > 18 years. Only students ≥ 15 years, an age when young people are close to the adult stage, were selected to minimize the possible impact of individual variations in biological maturity on the measurement of height and body weight. Thus, the final sample consisted of 1,538 adolescents (1,036 girls and 502 boys).

The chronological age of the participants was determined as the difference between the date of data collection and date of birth in years and months. However, two age groups were considered for the effect of analysis: 15-16 years (560 girls and 308 boys) and 17-18 years (476 girls and 194 boys). The anthropometric indicators of nutritional status were defined based on height and body mass index (BMI), i.e., the ratio between body weight in kilograms and the square of the height in meters (kg/m^2), according to the reference proposed by the World Health Organization (WHO-2007)[13]. BMI data instead of body weight alone were used because of the association between changes in linear growth and weight gain velocity during puberty as a result of events associated with biological maturation. As a consequence, the exclusive use of body weight as an indicator of nutritional status is not recommended for children older than 10 years[14].

Height was measured with a 1-mm aluminum stadiometer (Seca, model 870, Hamburg, Germany). Body weight was measured with an anthropometric scale (Seca, model 879, Hamburg, Germany) to the nearest 10 g. All measurements were made according to WHO recommendations[15]. The examiner team consisted of two physical education professionals with experience in these anthropometric measurements. Regarding data quality, replicates of body weight and height measurements were taken for every 10 subjects who participated in the definitive sample of the study. The magnitude of the technical error of measurement ranged from 30 to 50 g for body weight and from 1 to 5 mm for height.

The Statistical Package for the Social Science (SPSS), version 20.0, was used for statistical analysis. The anthropometric data were first compared

to a normal distribution using the Kolmogorov-Smirnov test and height and BMI showed a normal distribution. Descriptive statistics (mean and standard deviation) and two-way analysis of variance with interactions involving two classification criteria (gender and age) were used for characterization of the sample. When necessary, Scheffe's multiple comparisons test was applied to identify specific differences. For analysis of height and BMI of the adolescents selected in relation to the WHO-2007 reference, the chi-square (χ^2) test for adherence between observed relative frequency and percentile distributions of the WHO-2007 reference was used (< P10; P10-P20; P20-P30; P30-P40; P40-P50; P50-P60; P60-P70; P70-P80; P80-P90; > P90). The percentile distributions were calculated based on the values corresponding to L, M and S of each gender and age of the WHO-2007 reference. Significant differences between genders were identified using the chi-square (χ^2) test for homogeneity between the observed relative frequencies in girls and boys corresponding to the percentile distributions of the WHO-2007 reference.

RESULTS

Table 1 shows the statistical analysis of height, body weight and BMI in the sample selected for the study. Boys were heavier and taller than girls. BMI increased with age, but was similar in both genders.

Table 1. Mean, standard deviation and F statistics of height, body weight and body mass index in the adolescents studied.

Age	Height (cm)		Body weight (kg)		BMI (kg/m²)	
(years)	Girls	Boys	Girls	Boys	Girls	Boys
15	159.81±6.35	168.62±7.02 [a]	51.55±6.13	56.49±7.08 [a]	20,13±3,04	19,55±2,89
16	160.46±7.43	169.87±6.69 [b]	54.19±7.19	59.62±7.24 [b]	21,17±3,12	20,63±2,91
17	160.69±6.83	171.30±6.17 [b]	55.24±7.68	61.13±7.84 [b]	21,58±3,17	21,16±2,86
18	161.01±6.14	171.94±5.65 [b]	57.07±7.72	62.87±8.31 [b]	22,32±3,21	21,75±3,02
F_{age}	7.283 (p < 0.001)		18.283 (p < 0.001)		4.181 (p < 0.006)	
F_{gender}	60.378 (p < 0.001)		58.769 (p < 0.001)		2.911 (p = 0.122)	
$F_{interaction}$	21.140 (p < 0.001)		19.765 (p < 0.001)		1.441 (p = 0.098)	

BMI: body mass index. Superscript letters indicate significant differences between genders: [a] 0.01 < p < 0.05; [b] p < 0.01.

After the classification of height and BMI for each adolescent in relation to the percentiles of the WHO-2007 reference, the observed relative frequency was determined for each decile according to gender and age group. Table 2 shows the results obtained for height. In the two genders and age groups, a higher accumulation of adolescents was found in the first deciles, followed by a progressive reduction in frequency in the higher deciles. These findings suggest a high prevalence of adolescence with a height below that expected for age. The relative frequency ranged from 17-19% and from 1-3% in the first and last deciles, respectively, while a value of 10% would be expected, thus indicating an important height deficit. In the two genders, the chi-square test for adherence between observed relative frequencies and the expected uniform proportion of 10% revealed no significant difference

between age groups. However, the observed prevalence of height deficits was significantly higher in boys (χ^2 = 9.849, p = 0.002).

Table 2. Proportion (%) of adolescents with a height located within the percentiles of the WHO-2007 reference.

	Girls		Boys	
Percentile	15 – 16 years	17 – 18 years	15 – 16 years	17 – 18 years
< 10	17.4	18.1	18.7	19.2
10 – 20	15.6	15.9	16.4	17.1
20 – 30	13.7	14.0	14.7	15.4
30 – 40	12.3	12.8	13.5	13.8
40 – 50	10.8	10.3	10.5	10.7
50 – 60	9.7	9.9	9.4	9.2
60 – 70	8.2	7.9	7.2	6.9
70 – 80	5.3	4.8	4.2	4.1
80 – 90	4.1	3.9	3.0	2.5
> 90	2.9	2.4	2.4	1.1
χ^2_{age}	1.659 (p = 0.348)		2.178 (p = 0.196)	
χ^2_{gender}	9.849 (p = 0.002)			

Table 3 shows the observed relative frequency for BMI in relation to the percentiles of the WHO-2007 reference. In contrast to height, the concentration of observed cases in the first deciles was less than the expected 10% in both age groups, indicating a greater deficit in BMI among boys. In sequence, a clear trend of a gradual increase in frequencies was observed in higher deciles, with the observed relative frequencies and WHO-2007 reference being closely similar in intermediate percentiles. In the upper deciles (P70-80, P80-90 and P > 90), the relative frequencies were above the expected 10%, particularly among girls. In both genders, through chi-squared test for adherence was found that the observed relative frequencies differed significantly from the corresponding deciles proposed by the WHO-2007 references (χ^2 = 64.823, p < 0.001). The homogeneity test showed similar observed relative frequencies in the two age groups, whereas significant differences were observed between genders (χ^2 = 10.862, p < 0.001).

Figure 1 illustrates the comparison between the observed relative frequencies for height and BMI in relation to the WHO-2007 reference percentiles. Specifically regarding height, the observed relative frequencies in the first decile (17.8% of girls and 18.9% of boys) were almost twice the expected 10%, whereas only 2.7% of girls and 1.8% of boys were found above the 90th percentile. With respect to BMI, the observed relative frequencies in the highest decile (19.7% of girls and 19% of boys) were also almost twice the expected 10%, whereas in the lowest decile the observed relative frequencies did not exceed two percentage points (1.3% of girls and 1.4% of boys).

Table 3. Proportion (%) of adolescents with a body mass index located within the percentiles of the WHO-2007 reference.

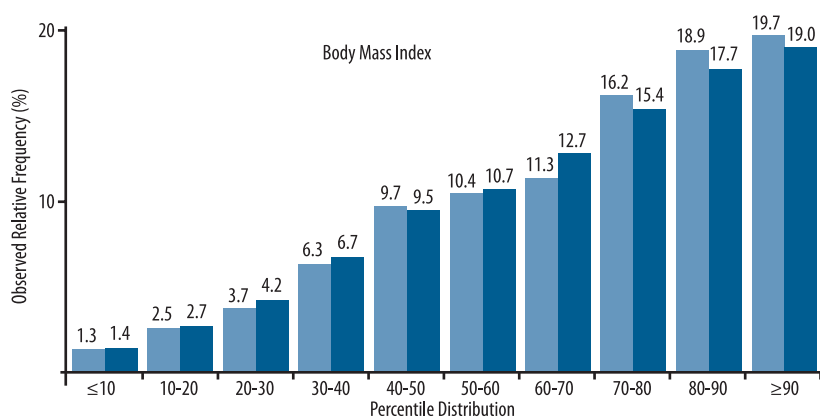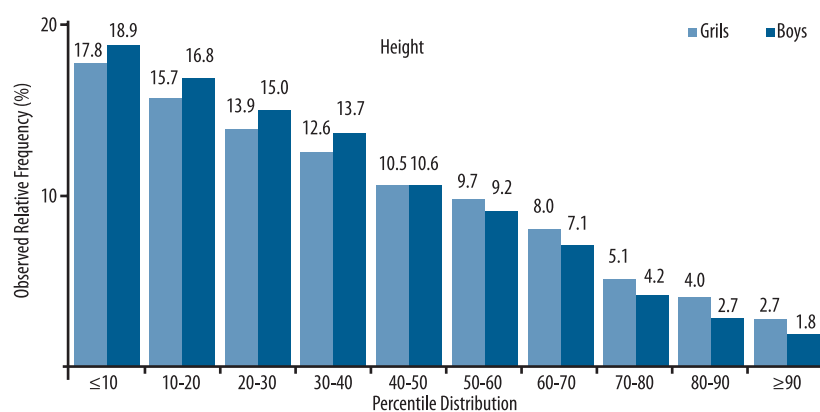|	Girls		Boys	
Percentile	15 – 16 years	17 – 18 years	15 – 16 years	17 – 18 years
< 10	1.4	1.1	1.5	1.2
10 – 20	2.7	2.3	2.9	2.5
20 – 30	3.9	3.4	4.5	4.0
30 – 40	6.5	6.1	7.1	6.4
40 – 50	9.8	9.5	9.6	9.5
50 – 60	10.5	10.2	10.8	10.6
60 – 70	11.3	11.6	12.6	12.8
70 – 80	15.9	16.7	15.2	15.6
80 – 90	18.7	19.0	17.2	18.1
> 90	19.3	20.1	18.6	19.3
χ^2_{age}	1.728 (p = 0.274)		2.396 (p = 0.117)	
χ^2_{gender}	10.862 (p < 0.001)			

Figure 1. Observed relative frequency (%) for height and body mass index in relation to the percentile distribution of the WHO-2007 reference in adolescents aged 15 to 18 years from a region of low economic development in Brazil.

DISCUSSION

In the present study, the anthropometric measures of height and BMI were used to estimate the nutritional status of a representative sample of adolescent schoolchildren from a region of low economic development in Brazil. The distribution of observed relative frequencies did not correspond to the deciles of the WHO-2007 reference, since no uniform proportions of 10% were observed. In both genders, the relative frequencies for height were markedly higher in the first deciles and deficient in the last deciles. These findings suggest that the levels of physical growth of the adolescents selected are below internationally accepted standards. With respect to BMI, the concentrations of relative frequencies were higher in the upper deciles, indicating a high prevalence of overweight adolescents.

Since the sample consisted of adolescents, the influence of individual variations in the stages of biological maturity on the identification of relative frequency distributions in relation to normative reference values cannot be ruled out. These individual variations can advance or delay the physical growth spurt, resulting in temporary advantages or disadvantages associated with height and body weight[14]. However, the height deficits and higher proportions of overweight/obesity observed in the present study do not seem to be attributable to this fact, since the greatest differences in comparison with the WHO-2007 reference were observed at 17-18 years, an age when the selected adolescents were probably already close to adult maturity.

According to the literature, the greatest height deficits and an increased risk of overweight/obesity in youth populations from developing regions are observed exactly in adolescence, even when controlling for factors related to the time of onset and duration of maturation[16-20]. This finding can be explained by the fact that significant alterations related to physical growth occur during this period of human development, thus requiring an adequate and balanced metabolic supply of energy, amino acids, vitamins and mineral salts, associated with various endogenous secretions[21]. In addition, delays in height growth identified at the end of adolescence may reflect specific aggravations resulting from the late and cumulative effects of nutritional stress that occurred at an earlier age[14].

The proportions of height deficits and overweight/obesity were not distributed equally among boys and girls in the population segment analyzed. On the one hand, height deficit proportions were significantly higher among boys while, one the other hand, the proportions of overweight/obesity were significantly higher among girls. Important differences in the frequency of height deficits and overweight/obesity between genders have also been reported in other studies[16-20].

The differences in height deficit proportions between girls and boys may be explained by sex differences in environmental sensitivity, particularly sensitivity to nutritional factors. Although the explanations and mechanisms underlying this phenomenon are not well defined, Stinson[22] found several studies that indicate the male organism to be more sensitive to

negative environmental influences. In this respect, under stressful environmental conditions, boys present a higher risk of prenatal mortality, physical growth retardation and development of contagious diseases than girls.

In contrast, the higher proportions of overweight/obesity among girls might be explained in part by the fact that the female organism is more vulnerable to body fat accumulation caused by sex hormones at ages close to puberty[23]. Differences in physical activity habits may also contribute to the differences in the prevalence of overweight/obesity between genders. In adolescence, boys are consistently more physically active than girls, either through daily activities or systematic exercise and sports programs, differences that become more marked with age[24].

The simultaneous presence of height deficits and overweight/obesity in the selected sample of adolescents may be related to the epidemiological transition recently observed in developing regions of Brazil. In this respect, specifically in the northern region of the state of Minas Gerais which was the target population of the present study, the social and infrastructure improvements in public services, especially in the education and health sectors, observed in recent years, together with the current welfare and income transfer programs, had a stronger impact on body weight increase than on the maintenance of the height growth potential of young people. A decade ago, no initiatives with these characteristics existed for the period of childhood of the current adolescents, a period that interferes strongly with the definition of future height. As a consequence, the high proportion of height deficits observed may also reflect specific nutritional deficiencies that occurred at an earlier age. A similar phenomenon has been observed for youth populations from other regions in Brazil[25,26] and from African countries[27], which significantly modifies trends in the prevalence of anthropometric indicators related to nutritional status.

In particular, low body weight/thinness, an important condition that affected the Brazilian child population in past decades[28], seems to be a nutritional problem that will soon be overcome in the population segment analyzed. In this respect, according to the statistical criterion adopted for the epidemiological classification of nutritional deficits, a prevalence of up to 2.5% is acceptable for populations with good nutritional status[15]. In the present study, the BMI proportions found in the lowest decile were close to 1.5%, a value similar to the acceptable proportion. However, while there is evidence indicating the possible control of low weight/thinness, the relative frequencies for BMI in the extreme upper deciles were higher than the expected 10%, indicating the urgent need for prevention and control measures.

One of the limitations of the present study was the definition of the sample selected. Since a specific population group consisting of adolescent schoolchildren of both genders aged 15 to 18 years from Francisco Sá, Minas Gerais, was studied, the results may not be extrapolated to youth populations from other regions of low economic growth in Brazil. However, since probability sampling and a large sample size were used, it is likely that the results satisfactorily portray the nutritional status of the youth

population of towns in the northern region of Minas Gerais. In addition, the cross-sectional design of the study does not permit to establish a causal relationship between the outcomes related to height deficits and overweight/obesity in the adolescents studied.

In conclusion, comparison of the height and BMI data observed in the present study with the WHO-2007 reference shows a significant difference in percentile distributions. The adolescents studied here presented important height deficits. In addition, although the population segment was from a region of low economic growth and with the lowest social indicators of the country, excess body weight for height was another important problem associated with nutritional status. The high proportions of overweight/obesity observed indicate the urgent need to implement public policies for health promotion, especially those designed to promote healthy eating habits and physical activity.

Since both height deficits and overweight/obesity are conditions with short- and long-term health consequences, the profile of the two nutritional indicators highlights the importance of maintaining measures designed to control hunger and malnutrition in the population. However, it is necessary to adapt current guidelines and to clearly define their benefits due to the possible effects that high-calorie foods with a low nutritional value, associated with a low level of physical activity, may exert on body fat accumulation. In this respect, access of the population to foods should be accompanied by specific educational measures that promote adequate food intake to meet nutritional requirements and regular physical exercise to increase energy expenditure.

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