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Analysis and Comparison of the Nutritional Status of Adolescents Utilizing Different Anthropometrics Indices

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Abstract

Objectives: Assessing nutritional status, verify anthropometric differences and compare the prevalence of inadequate nutritional status measured by different anthropometric indices between sexes in adolescents.

Method: 304 adolescents between the ages of 14 and 18 (boys 16.0 ± 1.2 and girls 15.7 ± 1.3; average ± SD) were evaluated. Anthropometric data was collected so it was determined the nutritional status through the body mass index (BMI), the Ponderal Index (PI), body fat (BF), waist-to-height ratio (WHtR), abdominal circumference (AC) and neck circumference (NC).

Results: The analyses of the nutritional status by the BMI, PI, AC and WHtR detected respectively 22, 19.4, 16.4 and 5.6% of the subjects were overweight/obesity with no statistical differences between the sexes. For the BF, 29.6% were determined as obese, with greater prevalence among the girls and for the NC, the prevalence of obesity was 21.4%, more prevalent amongst the boys.

Conclusions: The prevalence of overweight and obesity was elevated between adolescents. The boys demonstrated higher body mass, stature and neck circumference, whilst the girls demonstrated higher body fat. There was a high variation in the prevalence of overweight and obesity between the methods. The use of more than one anthropometric method for assessing nutritional status is proven to be an interesting strategy for the accurate detection of overweight /obesity in adolescents.

Keywords: Anthropometric indices; Overweight; Obesity; Students

Introduction

Obesity is considered to be the most ascendant chronicle disease in the world which reaches all age groups and social classes, both in developed countries and lower developed countries [1]. In Brazil, the comparison between The National Family Budget Survey (NFBS, 1974/1975) and the Living Standards Measurement Survey (LSMS, 1996/1997), showed that the percentage of adolescents who are overweight has more than tripled within two decades, from 3.7% to 12.6%, whilst the low weight had greatly reduced [2]. The results of the Household Budget Survey (HBS) conducted in 2008/2009 show that overweight and obesity in adolescents was 25.4%, which represents the double compared to the research of the previous decade [3]. These data are of concern since evidences show that excess weight in young people is a predictor of risk for its maintenance in adulthood [4].

Disorders resulting from obesity in adolescents include cardiovascular and metabolic diseases [5], which highlight the need for an accurate diagnosis for the prevention and early treatment of obesity. In the nineteenth century, it was developed the body mass index (BMI), which is a measurement of nutritional status which uses only body weight and height measurements [6]. Because of its convenience, low cost, being easily applied and also strongly associated with body fat, the BMI was widespread and used in population studies [7]. Later other equations were developed using the same measures [8] or other methods that estimate the body fat by skinfolds [9] and, even though they are less practical, they determine with some precision the body fat.

From the initial findings of Vague [10] on the differentiation of the effects of the location of body fat accumulation in adults on the development of diseases, in which he found that fat accumulation in the central region of the body, especially visceral fat, presents greater association with the development of diseases, various anthropometric indices were developed to assess central obesity [11-14]. In children and adolescents, increased visceral fat has also been associated with early development of chronic diseases such as diabetes, hypertension and dyslipidemia, leading to a number of health risks [15]. Thus, more recently, some studies have been developed in order to validate these anthropometric methods for the evaluation of central obesity in children and adolescents, determining specific cutoff points according to sex and age [16,17].

Although the development of different methods of assessment of nutritional status can enable the determination of different aspects of body fat, they can provide contradictory results, leading to doubts regarding the diagnosis of the subject and consequently the approach to be adopted. For that reason, this study aimed to evaluate the nutritional status, verify anthropometric differences and compare the prevalence of inadequate

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nutritional status measured by different anthropometric indices between sexes in adolescents.

Methodology

Sample

It was realized a cross-sectional study with a sample of 304 adolescents (194 boys) aged between 14 and 18 years (boys 16.0 ± 1.2 and 15.7 ± 1.3 girls), technical high school students from a Campus of the Federal Institute of Technological Education of Minas Gerais – Brazil. In a total of 473 students aged between 14 and 18 regularly enrolled in the fulltime integrated technical education in the school, 304 students (64.3%) completed all measurements. After collecting the data, the results were reported individually to the participants during a class in which it was discussed the risk of inadequate nutritional status (underweight, overweight, general and central obesity) and appropriate guidelines to minimize them. The study complied with the ethical criteria for research and was approved by the Ethics Committee of Human Research of the Federal Institute of Education, Science and Technology of southeast Minas Gerais, opinion number 03/2012. Consent was obtained from all children and their parents/guardians.

Procedures

The measures were collected by physical education teachers with experience in anthropometric techniques during their physical education classes, as part of regular physical assessment to which all of the students are subjected. Each teacher was responsible for one anthropometric measure in all students.

The assessment of the adolescents' nutritional status was conducted by anthropometry, using body mass, height, neck, waist and abdomen circumferences, besides triceps skinfolds and medial calf. The body mass and height measurements were collected with the student on light clothing and barefoot. The neck circumference measurement was taken at the point just inferior to the laryngeal prominence; the waist at the point of the smallest circumference and the abdomen above the navel, following the recommendations of Callaway et al. [18]. The triceps and medial calf skinfolds were measured on the right side of the body in triplicate, recording the average of these measurements. The triceps skinfold thickness was measured with the subject standing, in the middle part of the posterior arm region and the medial calf in the region of greatest circumference in the leg, with his leg relaxed and forming a right angle (90°) with his thigh, according to Harrison et al. [19].

With the anthropometric measurements collected in hands, the following anthropometric indices with the references of the classification criteria were calculated: body mass index (BMI = body weight/height^2) [20], ponderal index (PI = height (cm) / body weight (kg)$^{1/3}$) [21], waist-to-height ratio (WHtR = waist circumference / height) [17], abdominal circumference (AC) [16] and neck circumference (NC) [22].

For the estimation of body fat (BF), specific equations for boys were used [BF (%) = 0.735 (triceps + calf) + 1] and for girls [BF (%) = 0.61 (triceps + calf) + 5.1] using the protocol proposed by Slaughter et al. (1988) [9]. For the classification of the BF, it was adopted the criterion proposed by Going et al. [23].

To measure the body circumferences, body weight, height and skinfold thickness, it was, respectively, used a metal anthropometric tape with accuracy of 1 mm (Cescorf, Brazil); a portable digital scale with a maximum load of 150 kg and precision of 100 g (Lider LD1050, Brazil), a stadiometer with graduation of 0.1 cm (Sanny, Personal Caprice, Brazil) and a caliper (Lange, Cambridge Scientific Industries, USA) with accuracy of 1 mm.

Statistical Analysis

Initially, it was applied the Kolmogorov-Smirnov test to assess the normal distribution of data. Descriptive statistics was performed using the average, standard deviation, median, minimum and maximum value for each variable analyzed. The percentage distribution of overweight or obesity prevalence for each of the anthropometric methods used was also calculated. To compare the variables collected between the sexes, it was used the T test for independent measures when the variables showed normal distribution and the Mann-Whitney test when at least one of the groups did not show normal distribution. To analyze differences in prevalence between the sexes, it was used Chi-square test. Statistical analyses were performed using a statistical software (SPSS, version 20.0, Germany) and for all, it was adopted a significance level of $p < 0.05$.

Results

In table 1, it can be observed the characteristics of the sample investigated. Boys showed statistically higher values for weight, height, PI and NC compared to girls. On the other hand, the girls had higher values of body fat. For the other anthropometric variables, significant differences were not identified between the sexes.

Table 2 presents the percentages and absolute numbers of boys and girls and the whole sample, ranked within normality limits and the ones that exceeded the criteria of adequacy for each of the anthropometric indices. There was no difference in the prevalence of overweight or obesity between the sexes using the BMI results, PI, AC and WHtR, while for the BF, there was a higher prevalence of obesity among girls and the NC

Variables	Sex				P
	Boys (n = 194)		Girls (n = 110)		
	Average ± SD	Median (min – máx)	Average ± SD	Median (min – máx)	
BM (kg)	64,3 ± 12,9	63,15 (37,60 - 108,40)	55,8 ± 11,6	54,25 (33,50 - 102,50)	< 0,001[a]
Height (cm)	170,7 ± 7,0	171 (147 - 190)	160,2 ± 6,1	160 (142 - 178)	< 0,001[a]
BMI (kg/m^2)	22,0 ± 3,7	21,36 (15,45 - 37,58)	21,7 ± 4,1	21,00 (13,28 - 36,29)	0,51
PI (cm/kg$^{1/3}$)	42,9 ± 2,2	42,98 (34,99 - 48,57)	42,2 ± 2,5	42,39 (35,18 - 49,39)	0,01[a]
BF (%)	18,4 ± 8,5	16,07 (7,25 - 51,35)	30,2 ± 8,8	28,74 (14,56 - 59,39)	< 0,001[a]
AC (cm)	76,8 ± 9,1	75,35 (62,10 - 110,00)	75,9 ± 11,3	75,50 (53,20 - 108,40)	0,92
NC (cm)	34,7 ± 2,3	34,50 (28,50 - 44,00)	30,8 ± 1,6	30,80 (26,5 - 36,6)	< 0,001[a]
WHtR	0,42 ± 0,04	0,42 (0,35 - 0,60)	0,42 ± 0,06	0,41 (0,33 - 0,59)	0,91

[a]Significant difference between boys and girls - Mann-Whitney test

BM – body mass; BMI – body mass index; PI – ponderal index; BF – body fat; AC – abdominal circumference; NC – neck circumference; WHtR – waist-to-height ratio.

Table 1: Anthropometric characteristics of adolescents between 14 and 18 years, values expressed as average, standard deviation, median, minimum and maximum value according to sex.

Anthropometric Indices	Rank	Sex		P	Total % (n)
		Boys (n = 194) % (n)	Girls (n = 110) % (n)		
BMI (kg/m^2)	Normal	75.8 (147)	81.8 (90)	0.222	78 (237)
	Overweight	24.2 (47)	18.2 (20)		22 (67)
PI (cm/kg$^{1/3}$)	Normal	83.0 (161)	76.4 (84)	0.160	80.6 (245)
	Overweight	17.0 (33)	23.6 (26)		19.4 (59)
BF (%)	Normal	66.5 (129)	53.6 (59)	0.027[a]	61.8 (188)
	Obese	33.5 (65)	46.4 (51)[a]		38.2 (116)
AC (cm)	Normal	84.0 (163)	82.7 (91)	0.770	83.6 (254)
	Obese	16.0 (31)	17.3 (19)		16.4 (50)
NC (cm)	Normal	71.1 (138)	91.8 (101)	< 0.001[a]	78.6 (239)
	Obese	28.9 (56)	8.2 (9)[a]		21.4 (65)
WHtR	Normal	94.8 (184)	93.6 (103)	0,659	94.4 (287)
	Obese	5.2 (10)	6.4 (7)		5.6 (17)

[a]Significant difference of prevalence between boys and girls - chi-square test

BM – body mass; BMI – body mass index; PI – ponderal index; BF – body fat; AC – abdominal circumference; NC – neck circumference; WHtR – waist-to-height ratio.

Table 2: Prevalence of overweight and obesity in adolescents between 14 and 18 years old, assessed with different anthropometric indices.

resulted in higher prevalence among boys.

Discussion

Evaluating the boys, the inadequacy of nutritional status measured by different anthropometric indices ranged between 5.2% and 33.5%. Among girls, these percentages ranged between 6.4% and 46.4%. The prevalence of overweight measured by BMI was higher than the ones found in other national studies with similar samples [24,25], it was also observed in the present study mean values of body fat higher than the ones found by Farias Junior et al. [26], both for boys and girls.

These prevalences are very high and also higher than those found for the Brazilian population, especially for boys [3], which raises a concern about adolescent health, requiring interventional actions to improve the observed situation. As it has been observed high prevalence of physical inactivity among adolescents [27] and excessive consumption of foods high in fat and high caloric density [28], which are factors associated with the development of obesity, interventions focusing on the insertion of regular physical activity and diet quality improvements are proven to be important actions to control the nutritional status. Considering that adolescence is a stage in which the habits tend to be maintained even in adulthood, It is held an opportunity to intervene in health education, therefore it could be established healthy habits of life aiming health promotion.

Analyzing the anthropometric variables between the sexes (Table 1), body weight, height and neck circumference were significantly higher in boys, while the body fat was higher in girls. These findings are in agreement with the adolescent stage of development in which, by action of specific sex hormones, there are differences in anthropometric aspects between boys and girls, called sexual dimorphism [29]. In adolescents after the spurt of growth and under the action of testosterone, boys have greater development of body mass, muscle and height than girls, and these in turn under the action of estrogen have a higher body fat accumulation [29].

Comparing the prevalence of overweight/obesity among boys and girls evaluated by different methods, the differences were only found between the NC and the BF. In addition to the physiological differences by sexual dimorphism, behavioral differences may determine the differences in the prevalences between the methods. Some studies have shown that girls are more sedentary than boys [30,31]. This factor may be associated with a lower muscle development and an increase in deposits of body fat in girls at a level beyond the one determined by sex differences. Thus, the methods that assess overweight (BMI and PI) or central adiposity (AC and WHtR) have the limitation of not determining body composition, eventually equalizing the overweight prevalence between boys and girls. Despite this limitation, it has been shown that these methods have high validity in the detection of body fat [32-34]. Thus, in assessing the nutritional status of adolescents, the concomitant use of more than one anthropometric method proves to be an important strategy for detecting individuals with overweight/obesity, especially if one of the methods used determines the body composition, like the method analyzing skinfolds.

The NC showed opposite result to the BF, in which the prevalence of obesity was much higher in boys. Unlike waist circumference, which high values are determined by excess fat, while muscle mass has little influence on it, the NC is influenced by both body fat and muscle mass. Therefore, a hypothesis to explain the higher prevalence in boys may be related to the fact that NC was influenced by muscle mass. That's because many of the subjects assessed as obese by the NC were evaluated by BMI or the BF as normal. Likewise, the lower muscle mass of the girls resulted in a low prevalence of obesity when measured by the NC, which may represent a limitation of this method.

Conclusion

The results obtained in this study showed a high prevalence of overweight and obesity in adolescents, pointing to the need of interventions to reduce the observed values.

The comparison of anthropometric parameters between boys and girls determined a greater body mass, height and circumference of the neck for boys, while girls presented higher body fat, consistent results and normal during the stage of adolescence, where sexual dimorphism is pronounced.

The differences in prevalence between the sexes measured by different methods were observed for the NC and the % BF. Despite the different methods are valid according to literature, the use of more than one anthropometric method for assessing nutritional status of adolescents is indicated, aiming at a more accurate diagnosis.

References

1. Prentice AM (2006) The emerging epidemic of obesity in developing countries. Int J Epidemiol 35: 93-99.
2. Wang Y, Monteiro C, Popkin BM (2002) Trends of obesity and underweight in older children and Adolescents in the United States, Brazil, China, and Russia. Am J Clin Nutr 75: 971-977.

3. Instituto Brasileiro de Geografia e Estatística (2010) Pesquisa de Orçamentos Familiares 2008-2009. Antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil. Rio de Janeiro: IBGE.
4. Guo SS, Chumlea WC (1999) Tracking of body mass index in children in relation to overweight in adulthood. Am J Clin Nutr 70: S145- S148.
5. Franks PW, Hanson RL, Knowler WC, Sievers ML, Bennett PH, et al. (2010) Childhood obesity, other cardiovascular risk factors, and premature death. N Engl J Med 362: 485-493.
6. Eknoyan G (2006) A history of obesity, or how what was good became ugly and then bad. Adv Chronic Kidney Dis 13: 421-427.
7. Komlos J, Brabec M (2010) The trend of mean BMI values of US adults, birth cohorts 1882-1986 indicates that the obesity epidemic began earlier than hitherto thought. Am J Hum Biol 22: 631-638.
8. Billewicz WZ, Kemsley WF, Thomson AM (1962) Indices of adiposity. Br J Prev Soc Med 16: 183-188.
9. Slaughter MH, Lohman TG, Boileau RA, Horswill CA, Stillman RJ, et al. (1988) Skinfold equations for estimation of body fatness in children and youth. Hum Biol 60: 709-723.
10. Vague J (1956) The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. Am J Clin Nutr 4: 20-34.
11. Valdez R, Seidell JC, Ahn YI, Weiss KM (1993) A new index of abdominal adiposity as an indicator of risk for cardiovascular disease. A crosspopulation study. Int J Obes Relat Metab Disord 17: 77-82.
12. Han TS, van Leer EM, Seidell JC, Lean ME (1995) Waist circumference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample. BMJ 311: 1401-1405.
13. Ben-Noun L, Sohar E, Laor A (2001) Neck circumference as a simple screening measure for identifying overweight and obese patients. Obes Res 9: 470-477.
14. Ho SY, Lam TH, Janus ED (2003) Waist to stature ratio is more strongly associated with cardiovascular risk factors than other simple anthropometric indices. Ann Epidemiol 13: 683-691.
15. Oliveira CL de, Mello MT de, Cintra IP, Fisberg M (2004) Obesity and metabolic syndrome in infancy and adolescence. Rev Nutr 17: 237-245.
16. Fernández JR, Redden DT, Pietrobelli A, Allison DB (2004) Waist circumference percentiles in nationally representative samples of african-american, european-american, and mexican-american children and adolescents. J Pediatr 145: 439-444.
17. Maffeis C, Banzato C, Talamini G (2008) Waist-to-height ratio, a useful index to identify high metabolic risk in overweight children. J Pediatr 152: 207-213.
18. Callaway CW, Chumlea WC, Bouchard C, Himes JH, Lohman TG, et al. (1988) Circunferences. In: Lohman TG, Roche AF, Martorell R (eds), Anthropometric Standardization Reference Manual. Champaign: Human Kinetics Books.
19. Harrison GG, Buskirk ER, Lindsay Carter JE, Johnston FE, Lohman TG, et al. (1988) Skifolds thicknesses and measurement technique. In: Lohman TG, Roche AF, Martorell R (eds), Anthropometric Standardization Reference Manual. Champaign: Human Kinetics Books.
20. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, et al. () Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ 85: 660-667.
21. Ricardo DR, Araújo CG (2002) Body Mass Index: A Scientific Evidence-Based Inquiry. Arqu Bras Cardiol 79: 61-78.
22. Hatipoglu N, Mazicioglu MM, Kurtoglu S, Kendirci M (2010) Neck circumference: an additional tool of screening overweight and obesity in childhood. Eur J Pediatr 169: 733-739.
23. Going SB, Lohman TG, Cussler EC, Williams DP, Morrison JA, et al. (2011) Percent body fat and chronic disease risk factors in U.S. children and youth. Am J Prev Med 41: S77-S86.
24. Campos LA, Leite AJM, Almeida PC (2007) Prevalence of overweight and obesity among adolescent students in the city of Fortaleza, Brazil. Rev Bras Saúde Matern Infant 7: 183-190.
25. Farias Junior JC, Silva KS (2008) Overweight/Obesity in Adolescent Students From the City of João Pessoa, PB, Brazil: Prevalence and Association with Demographic and Socioeconomic Factors. Rev Bras Med Esporte 14: 104-108.
26. Farias Junior JC, Konrad LM, Rabacow FM, Grup S, Araújo VC (2009) Sensitivity and specificity of criteria for classifying body mass index in adolescents. Rev Saúde Pública 43: 53-59.
27. Da Silva RC, Malina RM (2000) Level of physical activity in adolescents from Niterói, Rio de Janeiro, Brazil. Cad Saúde Pública 16: 1091-1097.
28. Arruda ELM, Lopes AS (2007) Body fat, physical activity, and dietary patterns of Adolescents in a mountainous region of Santa Catarina State, Brazil. Rev Bras Cineantropom Desempenho Hum 9: 5-11.
29. Wells JC (2007) Sexual dimorphism of body composition. Best Pract Res Clin Endocrinol Metab 21: 415-430.
30. Oehlschlaeger MH, Pinheiro RT, Horta B, Gelatti C, San'Tana P (2004) Prevalence of sedentarism and its associated factors among urban adolescents. Rev Saúde Pública 38: 157-163.
31. Hallal PC, Bertoldi AD, Gonçalves H, Victora CG (2006) Prevalence of sedentary lifestyle and associated factors in adolescents 10 to 12 years of age. Cad Saúde Pública 22: 1277-1287.
32. Neovius M, Linné Y, Rossner S (2005) BMI, waist-circumference and waist-hip-ratio as diagnostic tests for fatness in adolescents. Int J Obes (Lond) 29: 163-169.
33. Garnett SP, Baur LA, Cowell CT (2008) Waist-to-height ratio: a simple option for determining excess central adiposity in young people. Int J Obes (Lond) 32: 1028-1030.
34. Fujita Y, Kouda K, Nakamura H, Iki M (2011) Cut-off values of body mass index, waist circumference, and waist-to-height ratio to identify excess abdominal fat: population-based screening of Japanese school children. J Epidemiol 21: 191-196.