Prevalence and concordance in the prediction of excess body weight by two anthropometric criteria in adolescents of western Brazilian Amazon

Prevalência e concordância na predição de excesso de peso corporal por dois critérios antropométricos em adolescentes da Amazônia ocidental brasileira

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Abstract – The aim of this study was to identify the prevalence and concordance of excess weight (BMI) and body fat (fat %) in adolescents of both sexes from cities of Rio Branco-AC and Porto Velho-RO. This study evaluated 4,310 adolescents, 2,167 from Rio Branco and 2,143 from Porto Velho. No difference (p=0.46) for excess weight between adolescents from Rio Branco (34.8%) and Porto Velho (33.8%) was observed. Fat percentage was significantly higher (p<0.01) in adolescents from Porto Velho (59.8%) compared to those from Rio Branco (44.3%). In intra-pubertal and pubertal stages, moderate concordance was identified (p<0.01) and in pre-pubertal stage, substantial concordance was observed (p<0.01). Thus, the findings of this study point out the adequacy of screening and diagnosis of obesity and overweight, which will enable earlier approach and treatment of adolescents.

Key words: Adolescents; Body fat; Body mass index; Overweight.

Resumo – O objetivo deste estudo foi verificar a prevalência e a concordância de excesso de peso (IMC) e de gordura corporal (% gordura) em adolescentes de ambos os sexos das cidades de Rio Branco–AC e Porto Velho–RO. Participaram do estudo 4.310 adolescentes, sendo 2.167 de Rio Branco e 2.143 de Porto Velho. Não houve diferença (p=0,46) entre o excesso de peso nos adolescentes de Rio Branco (34.8%) e de Porto Velho (33.8%). O % gordura foi significativamente maior (p=<0,01) nos adolescentes de Porto Velho (59,8%) em relação aos de Rio Branco (44,3%). Nos estágios intra–púbere e púbere foram identificadas moderadas concordâncias (p=0,01) e no estádio pré–púbere foi observado substancial concordância (p=0,01). Assim, os achados do presente estudo apontam para a necessidade da adequação do rastreamento da obesidade e sobrepeso que possibilitará identificação mais precoce e tratamento dos adolescentes.

Palavras-chave: Adolescente; Gordura corporal; Índice de massa corporal Sobrepeso.

INTRODUCTION

Puberty represents a period in which changes in the mass distribution of adipose tissue orchestrated by sex hormones occur[1]. Adolescents with excess body fat tend to become obese adults[2]. Thus, evaluating the nutritional status during the pubertal period has been recommended as a health indicator of the young population, allowing the identification of individuals at greater risk for the development of obesity.

National and international studies have revealed a high prevalence of both overweight and excess body fat in puberty[3-6]. Similar results have been reported in studies with children and adolescents in western Brazilian Amazon[7,8].

Among anthropometric indicators, body composition has been widely used due to its objectivity. Equations for estimating body fat percentage (Fat%) through skinfolds have been validated for the diagnosis of nutritional status in children and adolescents[9]. On the other hand, body mass index (BMI) is a widely used method for the diagnosis of overweight in populations due to its practicality and low cost. BMI is limited in the diagnosis of the main body components such as fat, bones, water and muscles[10].

A study with adults has revealed discrepancy between overweight by BMI and overweight and excess fat by Fat% in adults[11]. Similarly, moderate concordance between BMI indicators and fat percentage in the estimation of body adiposity was observed in children and adolescents[12,13].

Therefore, the aim of this study was to verify the prevalence and concordance of overweight by BMI and excess body fat by Fat% in adolescents of both sexes from the cities of Rio Branco (AC) and Porto Velho (RO).

METHODOLOGICAL PROCEDURES

This cross-sectional study was carried out with adolescents from the cities of Rio Branco (AC) and Porto Velho (RO) in the northern region of Brazil and located in southwestern Amazon. The study was approved by the Human Research Ethics Committee of the Federal University of Acre (UFAC) (CAAE: 23107.009169 / 2009-89) and Federal University of Rondônia (CAAE: 14190113.30000.5300).

The calculation to determine sample size was based on an estimated prevalence of 50% of overweight (overweight and obesity), a two-percentage-point sample error, 95% confidence level, and the representative sample of Rio Branco (AC) of 1,806 and Porto Velho (RO) of 1,786 high-school students in the age group of 14-18 years. Considering possible losses and refusals, 20% were added to this value, and the study was carried out with 2,167 and 2,143 students, respectively, with simple paired randomization between public and private schools, totaling 4,310 students.

The selection process of students took place in two stages: a stratified sampling proportional to the number of students in each school was initially carried out, and then a random sampling was carried out within each

school, including all public and private schools of the cities of Rio Branco (AC) and Porto Velho (RO). This sampling process allowed each student to be equally likely to be drawn, with loss replacement of up to 20%.

The stage of sexual maturation was obtained by the self-evaluation method, using photographs and written description of the five stages of breast development stages for females (M1 - M5) and genitals for males (G1 - G5) according to Marshall and Tanner[14,15] and students were asked to chose the photograph that best reflects their stage of development. Girls were asked about the presence or absence of menarche. M1 and G1 = pre-pubertal; M2 and M3 without menarche and G2 and G3 = intra-pubertal; and M3 post-menarche or M4 and M5 and G4 or G5 = pubertal.

Based on weight and height measurements, BMI was determined by the following formula: [body mass (Kg)/height (m^2)]. The classification of the nutritional status of adolescents was performed according to criteria proposed by the World Health Organization[16]. The cutoff points used were: zBMI <1.0 (eutrophic) and zBMI> 1.0 (overweight = overweight + obese).

Fat% was calculated according to equations of Slaugther et al.[9], which use triceps and subscapular skinfolds, considering sex, race (white and black) and sexual maturation. The cutoff points for excess fat were for males at ≥ 25 (with excess fat) and <25 (without excess fat); for females ≥ 30 (with excess fat) and <30 (without excess fat) [10].

Statistical analysis was performed using the SPSS 17.0® software. The chi-square test was used to compare the frequencies of groups with and without excess fat by zBMI and Fat% between cities, sex, type of school and sexual maturation. The Kappa index was used to verify the degree of concordance between zBMI and Fat% according to sexual maturation. Concordance values between 0 and 0.39 were considered weak, between 0.40 and 0.59, moderate, between 0.60 and 0.79, substantial, and above 0.80, excellent[17]. The significance level was 5%.

RESULTS

In this investigation, 4,310 adolescent students were evaluated. Of these, 2,167 were from the city of Rio Branco-AC and 2,143 from the city of Porto Velho-RO. The mean age was 15.65 ± 1.72 years, while the gender distribution was 46.7% for males and 53.3% for females.

The overall overweight prevalence was 34.3% (overweight 22.4% and obesity 11.8%). The overweight prevalence was 34.8% (overweight 22.7% and obesity 12.0%) in adolescents from the city of Rio Branco-AC and 33.8% (overweight 22.0% and obesity 11.7%) in adolescents from the city of Porto Velho-RO. On the other hand, the overall excess fat prevalence was 77.2%, being higher in the city of Porto Velho, 59.8% (Table 1).

Table 1 shows the overweight and excess body fat prevalence among high school students aged 14-18 years by city, sex, school type and pubertal stage.

Adolescents had similar overweight prevalence between cities of Rio Branco and Porto Velho (p = 0.46).

Regarding excess body fat, adolescent students from Porto Velho showed prevalence almost 10% higher than students from Rio Branco. Between sexes, greater overweight prevalence was observed in males (p <0.01) and, on the contrary, higher excess fat in females. A gradual increase in excess weight and excess fat from the pre-pubertal to pubertal stage was also observed (p <0.01).

Table 1: Excess weight (zBMI) and fat (Fat%) prevalence in students aged 14-18 years by city, sex, school type and pubertal stage of cities of Rio Branco (AC) 2010 and 2011 and Porto Old (RO) 2012 and 2013.

		Excess weight			Excess fat		
	n	Prevalence	%	p	Prevalence	%	p
City				0.46			< 0.01
Rio Branco	2167	755	34.8		1047	48.3	
Porto Velho	2143	724	33.8		1282	59.8	
Sex				< 0.01			< 0.01
Male	2014	731	36.3		999	49.6	
Female	2296	748	32.6		1330	57.9	
School				< 0.01			< 0.01
Public	2115	654	30.9		1186	56.1	
Private	2195	825	37.6		1143	52.1	
Stage				< 0.01			< 0.01
Pre-pubertal	161	30	18.6		48	29.8	
Intra-pubertal	881	280	31.8		422	47.9	
Pubertal	3268	1069	32.7		1859	56.9	

Chi-square (p <0.05); zBMI = z score of body mass index; Fat% = fat percentage % = Percentage

The degree of concordance between zBMI and Fat% according to sexual maturation at all stages was 0.42 (moderate), 0.67 (substantial) in the pre-pubertal group, 0.53 (moderate) in the intra-group and 0.41 (moderate) in the pubertal group (Table 2).

Table 2: Concordance between zBMI and Fat% in 4,310 students aged 14-18 years according to sexual maturation of the city of Rio Branco (AC) 2010 and 2011 and Porto Velho (RO) 2012 and 2013.

Fat%	zBMI		Kappa	p
	All stages			
	Normal	Excess		
Normal	1763	218	0.42	< 0.01
Excess	1068	1261		
Pre–pubertal				
Normal	112	01	0.67	< 0.01
Excess	19	29		
Intra– pubertal				
Normal	429	30	0.53	< 0.01
Excess	172	250		
Pubertal				
Normal	1222	187	0.41	< 0.01
Excess	877	982		

Kappa index: concordance between 0 and 0.39 weak; 0.40 and 0.59 moderate; 0.60 and 0.79 substantial and ≥ 0.80 excellent.

DISCUSSION

This research evidenced overweight prevalence of 34.3% and 33.8% of excess fat prevalence of 48.3% and 59.8% in students from the cities of Rio Branco (AC) and Porto Velho (RO). Excess weight and excess fat indicators presented moderate concordance in the intra-pubertal and pubertal stages, whereas in the pre-pubertal stage, substantial concordance was evidenced.

The high overweight and Fat% prevalence is consistent with results of investigations carried out in Brazil. In the city of Presidente Prudente (SP), Fernandes et al.[18] identified high overweight prevalence of 32.6% in adolescents aged 11-17 years from private schools. Likewise, Brasil et al.[19] evaluated 1,927 students aged 6-11 years in the city of Natal (Brazil) and found overweight prevalence of 33.6%. In Rio Branco (AC), a study carried out with students from the initial grades of elementary school showed overweight prevalence of 22.5%[20].

International studies have shown overweight prevalence similar to that of the present study. In southern India[5], adolescents showed overweight prevalence of 29.3%. Likewise, adolescents from Canada[21] (31.4%) and the United States[22] (34.9%) showed high overweight prevalence.

In this study, the overweight prevalence was higher in male adolescents and excess fat was higher in females. These differences can be explained by changes in body composition that occur differently between sexes. Loomba-Albrecht and Styne[23] and Veldhuis et al.[24] showed that women have a gradual increase in Fat% throughout adolescence, with evolution from 15% at 9 years to 25% after menarche, while male adolescents have a decrease in speed of body fat gain, reaching in the adult life with Fat% of approximately 13%. On the other hand, lean body mass in females shows a decrease in growth velocity at 12 years and becomes stable at 15-16 years. Males show gain of lean body mass until the age of approximately 17-19 years[23].

In the present study, overweight was more prevalent in adolescents from private schools. Similarly, studies conducted in southern Brazil by Suñe et al.[25] and Vieira et al.[26] showed higher overweight prevalence in students from private schools in contrast to students from public schools. Hobold and Arruda[27] found higher overweight and obesity prevalence in students who belonged to families with higher purchasing power. It is speculated that students in the private network are more exposed to factors that contribute to overweight, such as high sedentary behavior due to the use of electronic devices, little active commuting, greater consumption of industrialized foods, among others[25,26].

The moderate concordance between BMI and Fat% indicators identified in the present study was also observed in children and adolescents from Saudi Arabia[12] and Hungary[13]. Since BMI reflects both body fat and lean body mass, it may have induced moderate concordance among the investigated indicators. In addition, the concordance variations observed between maturational stages can be explained by differences in fat gain in the puberty stages[23].

This moderate association may also be related to the fact that BMI is less accurate as an indicator of adiposity[28], especially in the puberty

phase. Thus, in the pre-pubertal group, consisting of adolescents in stages M1 and G1, there was substantial concordance. At stages M1 and G1, body composition has not yet undergone the physiological modification of maturation of the hypothalamic-pituitary-gonadal axis.

Thus, during puberty in assessing body composition at individual level, BMI and Fat% should be used with caution as similar parameters in the diagnosis of overweight and excess body fat in adolescents aged 14-18 years, especially in groups that are above M2 and G2.

The use of a double indirect method in the diagnosis of body fat is a study limitation. Since the study involves a representative sample of the population of students from Rio Branco (AC) and Porto Velho (RO), it makes it possible to generalize the results to the population.

CONCLUSION

The high overweight and excess body fat prevalence evidenced in students from Rio Branco (AC) and Porto Velho (RO) is a serious public health problem. This study showed the need to adequately screen and diagnose excess weight (overweight and obesity) and excess body fat in adolescents. Thus, accuracy in screening will enable the earlier treatment of these adolescents, preventing the outcomes of pathologies associated with obesity in adult life.

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