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ANALYSIS OF THE CORRELATION BETWEEN THREE ANTHROPOMETRIC MEASURES OF BODY WEIGHT IN SCHOOLCHILDREN

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ABSTRACT
Some studies have questioned the BMI as the only criterion for defining overweight and obesity. Our objective was to determine the correlation between the three most used anthropometric measures for detection of excess of weight and obesity- body mass index (BMI), waist circumference (WC) and excess of body fat (%BF) through the subscapular and the triceps skinfolds thickness. This is a cross-sectional study comprising 460 volunteer students, ranging from 7 to 12 years old, from one public and one private school located in Canoas, Rio Grande do Sul, Brazil. The frequency of obese patients, according to the BMI percentile was 51.4%; WC was 25.21% and %BF was 36.30% without percentage differences between the two schools. The correlation between the three measures, according to Spearman test was r > 0.80. The strong correlation suggests that BMI itself is a good indicator for detecting obesity in schoolchildren.

Keywords: Pediatric obesity. Waist Circumference. Body fat distribution. Body Mass Index. Correlation.

INTRODUCTION

Childhood obesity is a syndrome of physiologic, biochemical, anatomical, metabolic, psychological and social, characterized by an increase in adipose tissue, resulting in increased body weight. Seems to be strongly associated with the lifestyle and behavioral habits promoted by a culture of excessive consumption, eating fast food and industrialized, and the sedentary lifestyle. It is an organic disease, chronic that has no cure so far and whose treatment is extremely difficult and multidisciplinary focus[1].

In addition to the consequences of chronification obesity, overweight and obesity in children are associated with significant reduction in quality of life and greater risk of provocations, bullying and social isolation, as well as depression and decreased self-esteem[2-4].

The body mass index (BMI) is recommended by the World Health Organization (who) for evaluation and classification of nutritional status in children, adolescents and adults. However, your interpretation in terms of risk and prognosis in children and teenagers, has been treated with increasing caution. That due to changes that occur during growth, due to the biological maturation, when the proportions and body shapes, body fat, muscle mass may change quickly in periods and with different intensities. And today we know that the IMC is limited to the assessment of body fat and total[5].

Thus, other anthropometric measurements, also low cost and non-invasive, has been used for assessment of obesity and its risks. Among them, the Waist Circumference (CC) and the skinfold Thickness[6]. The circumference of the waist, such as BMI, is unable to determine body fat. Studies indicate that the percentage of fat is the best measure of cardiovascular risk[7] as well as predictor of insulinorresistência with consequent increase in risk for type 2 diabetes mellitus and cardiovascular disease[8].

Measures of subcutaneous folds has been increasingly used for body composition assessment and the level of adiposity. This percentage is obtained by summation of two skin folds can estimate the percentage of body fat and your relationship with the health[9]. Thus, these three measures are used together, such as anthropometric

[1]Extracted from the Dissertation "The Behavior of Sleep and Obesity: A Study of Prevalence in Children from 07 to 12 years old from two schools of the Municipality of Canoas – RS" presented to the Master of Health and Human Development of Universidade La Salle (UNILASALLE) - Canoas - RS.

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indicators of Overweight/obesity (IASO)[10], seem to offer a better detection of overweight, obesity and its risks in childhood and adolescence.

In the face of growing work questioning the BMI as a measure to evaluate risks related to excess weight in childhood and adolescence in both sexes, this study aims to analyze the correlation between the three anthropometric measurements in order to contribute to the discussion of the necessity of using multiple anthropometric measurements for detection of overweight and obesity.

METHODOLOGY

This is a cross-sectional design study. Participated voluntarily 460 children, aged 12 years, from 07 to a public and a private school in the city of Canoas, southern Brazil. The total number of children can participate in the research in the two schools was of 1100 students. Were included in the study all children who have the term of free and informed consent signed by the parent or guardian and Assent signed by the child. All were evaluated consecutively in their own schools. We exclude children who have inadequate conditions for anthropometric assessment, such as the use of prosthetics, cast, disabilities, making a total of 8 children. The data were collected in May 2014 in schools.

The analyzed variables were: **IMC:** For determining the body mass index (BMI) the parameters height and weight were measured as indicated by the Ministry of health, Brazilian Society of Pediatrics and the World Health Organization. The values found were analyzed and distributed in percentage or Z scores, according to sex and age (5 to 19 years), using as references the instruments proposed by the who (2007), considering the cut-off points for overweight and obesity above 85 and 97 percentiles respectively. **HEIGHT:** The measure was passed with precision measuring tape 2 m/0, 1 cm. **WEIGHT**: balance mechanical pendulum was used Welmy brand model R110 with accuracy of 100 g and a maximum of 150 kg, serial number 78539, Inmetro standardization Ordinance 146/2003, with accuracy class III and Scouting seal n° 003429240-6 and verification seal ««n° 1061478-3. **WAIST CIRCUMFERENCE (CC)**: For the measurement of CC we use a tape measure and measured inelastic the midpoint between the last rib and iliac Crest being classified according to proposal of Friedman et al. (1999)11, considering how increased risk for percentile greater than or equal to P90. SKINFOLD **MEASUREMENTS TRICIPTAL (DCT) AND SUBSCAPULAR (DCS)**.

We use specific equations for youth set (12) based on the variables related to ethnicity (white and black) and the maturacional-level13 that identify the stages of sexual maturation: prepuberal pubescent, and (post-pubescent). The equations are as follows: E2 = sum of DC triceps and subscapular, less than or equal to 35 mm. **White boys**: level of maturation: Pre-pubescent% GA = 1.21 (E2)-0.008 (E2)2-1.7; Pubescent-% GA = 1.21 (E2)-0.008 (E2)2-3.4. **Black boys**: level of maturation: Pre-pubescent-% GA = 1.21 (E2) -0.008 (E2)2-Pubescent 3.5-percent GA = 1.21 (and2)-0.008 (E2)2-5.2. **Girls of any race and level of maturity** –% GA = 1.33 (and2)-0.013 (E2)2-2.5. When the sum of the values of the thickness of skin folds performed more than 35 mm, used a single equation for each sex, regardless of race or maturacional State. Boys-% GA = 0.783 (E2) + 1.6; -% GA = 0.546 (TR + IF) + 9.7.

Procedures

Contact directions of educational institutions for a letter of introduction to participate in the research, being requested authorization following the ethical procedures. After consent of the directions we get in touch with their teachers in order to draw up a plan for the collection of data that doesn't get in the way of the routine activities in the classroom. Next, inform families in parent as per letter informative, about the objectives of the research. Received the authorization of the responsible, verbally clarified the objectives, confidentiality and dynamics of the data collection process by the investigator to the students requesting that allow the participation, complete your name at the end of Nod Free and clear (TALE), taking a copy of the document.

The measurement followed the order below:
Stature: The appraiser has positioned itself on the right side of the foot that was evaluated in standing position, bare feet and remaining stop on the United brand Welmy stadiometer, oriented to be with the pelvic girdle attached, and with his head driven in Frankfurt. The cursor or square, at an angle of 90° to the scale, touched the highest point on the head at the end of inspiration, where took place the reading in meters. **Body Mass**: the evaluator remained

standing facing measurement range and the evaluated was on the platform of the mechanical balance by placing one foot at a time and positioning yourself in the center of the same, loose arms sideways and look at a fixed point to your front. **Waist circumference**: the evaluator positioned facing the evaluated in standing position with the evaluated standing, relaxed abdomen, and arms relaxed at your sides. The flexible measuring tape with 01 mm accuracy was placed horizontally at the midpoint between the bottom border of the last rib and iliac Crest; the measurements were performed with the tape firmly onto the skin; However, no compression on the tissues. The waist circumference was measured in the smallest circumference of the abdomen, and at the end of a normal expiration, the waist was devoid of clothes. **Triceps skinfold (DCT) and subscapular (DCS)**: procedures for both measurements followed the criteria of correct position (a), and standing, in upright position, with the feet apart the width of the hips and the head guided in the Frankfurt plane, and position of the evaluator, being behind the review. The DCT was set parallel to the longitudinal axis of the arm, the average distance between the edge super lateral of the acromion and the process of Olecranon, the ulna, the doubles were clamped vertically with the anatomical muscle sense. The DCS was set about to 2 cm below the inferior angle of the scapula, and highlighted obliquely to the longitudinal axis. The evaluator guided the assessed to perform abduction and flexion of the arm back, which facilitates the removal of the scapula in order to mark the spot for the measurement. **Appraisers**: participated in a nurse, an academic psychology course, 02 graduates in physical education and a student of pedagogy of UNILASALLE, beyond the researcher responsible. The evaluators were trained by the researcher. For the performance of anthropometric measurements, we split the Group of evaluators by type of procedure and gauging getting a charge along the same measurement and procedure.

Statistical Analysis

First, we performed a descriptive and exploratory analysis with evaluation of the distribution of numeric variables. The numeric variables that have not had normal distribution were treated with nonparametric tests (Mann-Whitney and Kruskall Wallis). After comparison of proportions, and calculation of ratios of prevalence with Chi-square test, 95% confidence interval (CI 95%). Spearman correlation test was used to measure the bivariate correlations, and categorical variables were evaluated through Kruskall Wallis test. It was estimated the Spearman coefficient to evaluate the relationship between BMI and other anthropometric variables, whereas the level of significance of 5%. Was considered strong, positive correlation values 0.70 to 1, moderate 0.3 to 0.7, and weak 0.3 to 0 and strong negative correlation values between-0.70 to -1, moderate-to-weak 0.3 0.7-0.3 to 0. It was adopted a significance level of 0.05 for all analysis with two-tailed test.

Ethical aspects

The research has the approval by the Ethics Committee of the Centro Universitário Unilasalle Canoas-RS – under the number 546,295 in 13/12/2013 day.

RESULTS AND DISCUSSION

The sample was composed of 460 children from 7 to 12 years. Most of the females, with median age of 9 years. Predominance of white color, attending private school, as well as in most of your studying in the afternoon, according to table 1.

Table 1. Socio-Demographic Characteristics

FEATURES	**Total (%) 460**
SEX *	
Male	222 (48.3)
Female	238 (51.7)
AGE	
7 years	64 (13.9)
8 years	99 (21.5)
9 years	78 (17.0)
10 years	100 (21.7)
11 years	79 (17.2)
12 years	40 (8.7)
COLOR *	
White	426 (92.6)
Other	34 (7.4)
SCHOOL *	
Particular	262 (57.0)
Public	198 (43.0)
SHIFT	
Morning	90 (19.6)
Late	307 (66.7)
Night	63 (13.7)

*** p > 0,05**

In relation to anthropometric characteristics of the sample, we observed that the average waist circumference was greater in girls, although not statistically significant. The anthropometric measurements in this study had not parametric distribution. We observe that the medians approached in all measures as table 2.

Table 2. Features of anthropometric measurements in sex

FEATURES	MALE Mean (Sd) [95% CI] MEDIAN	FEMALE Mean (Sd) [95% CI] MEDIAN	TOTAL
Height (m)[1]	1.39 (0.11) [the 1.38 1.41] 1.39	1.39 (0.11) [the 1.38 1.41] 1.39	460
Body mass (kg)[2]	39.32 (12.59) [37.65 to 40.99] 36.15	37.79 (11.21) [36.35 to 39.22] 36.30	460
Body mass index [3]	19.91 (4.16) [19.36 to 20.47] 18.69	19.05 (3.51) [18.60 to 19.50] 18.43	460
Waist circumference[4]	69.29 (12.33) [67.65 to 70.91] 66.25	109.07 (64.38) [26.85 to 191.28] 65.75	460
% Body fat [5]	22.02 (13.69) [20.20 the 23.84] 17.09	21.18 (8.41) [20.10 the 22.26] 18.90	460

Mann Whitney test- 1 p = 0.80; 2 p = 0.25; 3 p = 0.06; 4 0.37; 5 p = 0.09

The anthropometric measurements showed distinct frequencies. By IMC, the frequency of obesity was 51.74%. Already, the frequency of abdominal obesity, assessed by waist circumference was 25.21%. And the frequency of excess fat, evaluated by the body fat percentage (% GC) was 36.30%. In relation to IMC and% GC, the boys presented a higher frequency of obesity and excess fat. Already the waist circumference, presented more frequently in girls. See table 3.

Table 3. Frequency of Obesity, abdominal obesity and excess fat

Anthropometric Measure	Classification	Male n (%)	Female n (%)	Total n (%)
BMI *	Normal	36 (16.2)	55 (23.1)	91
	Obesity	131 (59)	107 (45)	238 (51.74)
Waist circumference **	Normal	170 (76.6)	174 (73.1)	344
	Obesity	52 (23.4)	64 (26.9)	116 (25.21)
% Body Fat ***	Normal	48 (21.6)	89 (37.4)	137
	Obesity	98 (44.1)	69 (29)	167 (36.30)

* Chi quadrado = 6,31 e p < 0,01;
** Chi-quadrado = 0,73 e p = 0,39;
*** Chi quadrado = 16,8 e p < 0,0001.

In a study on evaluation of excess body fat in adolescents14, using different anthropometric indicators demonstrated that the difference in the prevalence of overweight/fat of the sample studied was up to 400% depending on the parameter anthropometric used. Some factors are cited for this:

a) discriminatory Capacity measures as indicators of mass, fat or adiposity; (b)) kind of Overweight/obesity measured by anthropometric measure (total, peripheral, central and trunk); c) cut-off points for overweight and body fat used to sort the anthropometric indicators. In this sense, each anthropometric method has advantages and limitations in global assessments and probably complement each other discriminatory aspects. In our study, males had a higher frequency of obesity (BMI) and excess fat with statistical significance, see table 3. Already in relation to the waist circumference, females had higher frequency (26.9% to 23.4% for boys and girls), however, there was no significant difference. In a study with Gauchos of the 11 school 14 years15, the prevalence of abdominal obesity was 28.7%, next to our study of 25.21% and the prevalence of excess body fat was 40.1%, also next to our study of 36.30% showed greater prevalence of abdominal obesity in girls.

According to table 4, we see that different frequencies and showed a statistically significant positive correlation and strong.

Table 4. Analysis of correlation between BMI, CC and % GC (Spearman's rho)

IASO	**GENERAL**		
	IMC	**CC**	**% GC**
IMC	-	0.903 *	0.867 *
CC	0.903 *	-	0.847 *
% GC	0.867 *	0.847 *	-
	MALE		
	IMC	**CC**	**% GC**
IMC	-	0.921 *	0.892 *
CC	0.921 *	-	0.876 *
% GC	0.892 *	0.876 *	-
	FEMALE		
	IMC	**CC**	**% GC**
IMC	-	0.887 *	0.873 *
CC	0.887 *	-	0.821 *
% GC	0.873 *	0.821 *	-

* $p < 0,001$

Was found a strong positive correlation between variables, with rho > 0.80. It remained between the sexes, with greatest strength among males, as the coefficients shown in table 4.

Despite differences in the frequencies of obesity (see Table 3) by evaluated indices, showed a strong positive correlation between them. The largest was between IMC and CC which remained when adjusted for sex. Other studies [16,17,18] also found a strong correlation between the indices, reaching a positive correlation between themselves in rho > 0.75, next to our findings.

The concomitant use of indicator of abdominal obesity (CC), in addition to the excess weight (BMI) can contribute a little more need for assessment of cardiovascular risk. But it is worth mentioning that all indexes had seating capacity of detection of more than half in relation to the other. For example, of 238 children with BMI indicating obesity, 47.5% had waist circumference changed, indicating a group of important cardiovascular risk. The same situation occurs between the others. It is worth mentioning that still lack, in Brazil, standardized prediction values for CC, although we used the equation already used in other Research [14.18].

As limitations of this study, we have the sampling process for volunteers, which would justify the high frequency of obesity (BMI) in the sample, because maybe there was great interest on the part of caregivers and children with obesity; the fact of the study be transverse and not allow causality effect, besides the possibility of reverse causality. And was not given the technical error of measuring data collection team that, although well-trained, variations in implementation are unknown. What can bring a degree of greater reliability is that the same rater performed the same task. These limitations can make limited external validity, getting around analysis of the data of the sample studied.

FINAL CONSIDERATIONS

Our research strengthens other studies since 2011, indicating that the IMC has important value, by itself, to obesity in addition to be predictive for cardiovascular risk. But as we have seen, in relation to the obese, obese waist circumference had above 90 percentiles and had obese with excess body fat and obese had no change in other anthropometric measurements in addition to BMI. These data suggest that if the goal is not just the overweight, but identify specific risk groups or the search of different strategies for the purpose of any type of intervention, in terms of monitoring nutritional, dietary re-education, including these distinct groups, family or high cardiovascular risk (IMC + CC changed), other measures may contribute to important clinical specifics.

ANÁLISE DA CORRELAÇÃO DE TRÊS MEDIDAS ANTROPOMÉTRICAS DE PESO CORPORAL EM ESCOLARES

RESUMO

Estudos vêm questionando o IMC como critério único para definição de sobrepeso e obesidade. Nosso objetivo foi verificar a correlação entre as três medidas antropométricas mais utilizadas para detecção de excesso de peso e obesidade: índice de massa corporal (IMC), circunferência de cintura (CC) e excesso de gordura corporal (%GC) através das dobras cutâneas tricipital e subescapular. Trata-se de um estudo transversal com 460 escolares voluntários de 7 a 12 anos de uma escola particular e outra pública de Canoas – Rio Grande do Sul, Brasil. A frequência de obesos, pelo percentil do IMC, foi de 51,4%; de CC foi de 25,21% e de %GC foi de 36,30% sem diferenças percentuais entre as duas escolas. A correlação entre as três medidas, com teste de Spearman, foi de r > 0,80. A forte correlação encontrada sugere que o IMC, por si só, é bom indicador para detecção de obesidade em escolares.

Palavras-chave: Obesidade pediátrica. Circunferência de cintura. Distribuição da Gordura Corporal. Índice de massa corporal. Correlação.

ANÁLISIS DE LA CORRELACIÓN DE TRES MEDIDAS ANTROPOMÉTRICAS DE PESO CORPORAL EN ESTUDIANTES

RESUMEN

Los estudios han cuestionado el IMC como criterio único para la definición de sobrepeso y obesidad. Nuestro objetivo fue verificar la correlación entre las tres medidas antropométricas más utilizadas para la detección de exceso de peso y obesidad: el índice de masa corporal (IMC), la circunferencia de cintura (CC) y el exceso de grasa corporal (%GC) a través de los pliegues cutáneos tricipital y subescapular. Se trata de un estudio transversal con 460 estudiantes voluntarios de 7 a 12 años de una escuela privada y otra pública de Canoas - Rio Grande del Sur, Brasil. La frecuencia de obesos, por el percentil de IMC, fue del 51,4%; de CC, fue de 25,21% y de %GC fue de 36,30% sin diferencias porcentuales entre las dos escuelas. La correlación entre las tres medidas, con prueba de Spearman, fue de r> 0,80. La fuerte correlación encontrada sugiere que el IMC, por sí solo, es un buen indicador para la detección de obesidad en los estudiantes.

Palabras clave: Obesidad Pediátrica. Circunferencia de la cintura. Distribución de la grasa corporal. Índice de masa corporal. Correlación.

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