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Comparing the Diagnostic Criteria of Metabolic Syndrome in Schoolchildren: Cross-sectional Study

ORIGINAL

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Abstract

Introduction: The Metabolic Syndrome has been highlighted by being the result of the meeting of several cardiovascular risk factors. However, there is still no consensus for the determination of MS in children and adolescents, since the diagnostic criteria and its cut-off points considered at risk are not established and, depending on the criteria used, the prevalence of MS found in the literature may vary.

Objective: To compare the diagnostic criteria for metabolic syndrome in adolescents in the private school system.

Method: This is a cross-sectional study of 325 adolescents from private schools in the urban area of a city in northeastern Brazil. The analysis was performed through the descriptive statistics, and the verification of the agreement between the results was given by the calculation of the Kappa index. The study was approved by the Ethics Committee (opinion 352.372).

Results: In only 7 adolescents, the diagnosis was like the three definitions of metabolic syndrome. Regarding the number of components of metabolic syndrome, a large percentage of adolescents presented 02 or more altered parameters. Regarding the comparison of the diagnostic criteria, the criteria established by De Ferranti presented a higher positive proportion for the syndrome.

Conclusion: There were differences between the proportions obtained through the three diagnostic criteria, which may impair the diagnosis of the metabolic syndrome in adolescents.

Keywords
Metabolic X Syndrome; Diagnostic Techniques and Procedures; Adolescent Health.

Introduction

In Brazil, as in other developing countries, there is a reduction in the occurrence of cases of malnutrition and, in a collateral manner, an increase in the prevalence of overweight. This nutritional transition is a consequence of a society characterized by poor living habits, such as unbalanced eating and sedentary lifestyle, leading to a growing increase in the incidence of Chronic Noncommunicable Diseases (DCNT).

The constant socioeconomic and cultural changes that have been taking place in Brazil in recent decades have led to behavioral changes and, consequently, to the eating habits of people, especially adolescents. The increase in the consumption of processed foods and snacks with a high concentration of fats and sugar has raised the rates of overweight and obesity in children and adolescents between 6 and 18 years old in Brazil and the rest of Latin America. In a study conducted by the National School Health Survey (PENSE), the prevalence of overweight and obesity was 21.5% and 5.8%, respectively [2].

In this context, Metabolic Syndrome (MS) has gained prominence, since it results from the meeting of several cardiovascular risk factors (CRF), such as systemic arterial hypertension (SAH), disorders of glucose and lipid metabolism, and visceral obesity [3]. However, its study has been hampered by the lack of conformity in its definition.

The World Health Organization (WHO) suggests that insulin resistance or glucose metabolism disorder is initially assessed, hindering its use. As for the National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATP III), MS represents the combination of at least three CRFs in an adult: abdominal obesity, increased triglycerides (TG), glucose intolerance, HDL-cholesterol (HDL-c) and increased blood pressure (BP) [4, 5].

However, there is still no consensus for the determination of MS in children and adolescents, since the diagnostic criteria and its cut-off points considered to be at risk are not yet established and, depending on the criteria used, the prevalence of MS found in the literature may vary [6]. NCEP-ATP III-based authors defined MS in pediatric populations as having three or more of the following criteria: abdominal obesity ≥ p90, fasting glycemia (GJ) ≥110mg/dL, TG ≥100mg/DL, HDL-c <40mg/dL and BP ≥90, adjusted for age, gender and height percentile [7].

Despite the relevance of the theme, in Brazil, especially in the Northeast, few epidemiological studies have explored this issue in children and adolescents. In this sense, this study aimed to compare different diagnostic criteria of MS in adolescents enrolled in the private school system, in the city of Picos-Piauí.

Method

A cross-sectional study carried out from April 2014 to May 2015, as part of the research: "Prevalence of Metabolic Syndrome and Risk Factors for Cardiovascular Diseases in Children and Adolescents of Picos-PI", developed by the Research Group in Public Health (GPeSC) of the Federal University of Piauí (UFPI), whose project was funded by the National Council for Scientific and Technological Development/Foundation for Research Support of the State of Piauí (CNPq/FAPEPI) - PPSUS.

The population was composed of all adolescents aged 10 to 19 years old, regularly enrolled in private schools in the urban area. For the calculation of the sample size, the formula for cross-sectional studies with finite population $n = (Z\alpha^2 * P * Q * N)/(Z\alpha^2 * P * Q) + (N - 1) * E^2$, where n = Sample size; $Z\alpha$ = confidence coefficient; N = population size; E = absolute sampling error; Q = complementary percentage (100-P); P = proportion of occurrence of the phenomenon under study [1].

The 95% confidence coefficient (1.96), the sampling error of 3% and the population of 4500 adolescents (N = 4500) were used as parameters. The

lowest expected prevalence was considered among the variables chosen for study (7% for arterial hypertension) (P = 0.07) [2]. After applying the formula, the sample consisted of 325 adolescents of both genders.

Participants were proportionally selected according to the number of students enrolled in each school. As criteria for inclusion, they were listed as: being between the ages of 10 and 19, accepting to participate in the research and signing the free and informed consent form, and having the consent of the parents or guardians, through the signing of the free and informed consent form. Those who were absent on the day of collection or who attended it without being fasted were excluded.

For this study, the following variables were considered: body mass index (BMI), waist circumference (CC), conicity index (IC), waist/height ratio (RCE), systolic blood pressure and diastolic (PAS/PAD); and as metabolic variables: TG, HDL-c, and GJ.

To measure weight and height were used: G-Tec brand scale with digital display and a Seca stadiometer. For the classification of nutritional status, the criteria proposed by the WHO in 2007 were adopted, using the BMI/age indicators, percentile [8]. In the measurement of WC, an inelastic and flexible tape measure measuring 150 cm in length was used, with one decimal point accuracy. The measurement was made, standing on a flat and smooth surface, standing upright, relaxed abdomen, arms arranged along the body and feet together. The narrowest part of the trunk between the last rib and the iliac crest [9] was circled with the tape. Three measurements were taken, considering the arithmetic mean of the values.

The RCE was obtained using the formula: RCE = CC (cm)/Height (cm). The calculation of the IC was obtained as follows in the following equation [10]:

$$\text{Index C} = \frac{\text{Waist circumference (m)}}{0{,}109\sqrt{\frac{\text{Body weight (Kg)}}{\text{Height (m)}}}}$$

The BP was verified by the classic auscultatory method, following the procedures recommended by the Brazilian Hypertension Guideline, using appropriate sizes cuffs, according to the circumference of the arms of the adolescents, considering the means of two measures of PAS and PAD, measured in the adolescent, after 5 minutes of rest [11]. When the difference between the first and second measures of PAS or PAD was greater than 5 mmHg, a third measurement was performed, and the final value was obtained by the mean between the last two measurements. For the classification of BP, the curves were used to determine the percentile of the adolescent´s height, according to age and gender, according to the National High Blood Pressure Education Program of the United States and the BP percentile table [11, 12].

After a 12-hour overnight fast, the participants underwent venous blood collection, performed by the laboratory staff in the school. The samples were conditioned in vacuum-closed tubes containing separator gel, without anticoagulant, and sent to the biochemical analysis. The collected blood was centrifuged for 10 minutes at 3,000 rpm, to isolate the serum from the other components, and it was used for the analysis. Triglycerides and blood glucose were measured using a colorimetric enzyme kit, processed on the Autohumalyzer A5 (Human-2004). For insulin dosing, Automated Chemiluminescence System ACS-180 (Ciba-Corning Diagnostic Corp., 1995, USA) was used.

The metabolic syndrome was identified through three diagnostic criteria **(Table 1)**, based on the definitions of Cook, Weitzman, Auinger, Nguyen, Dietz [7], De Ferranti, Gauvreau, Ludwig, Neufeld, Newburger, Rifai [13] and the third, from the consensus proposed by the International Diabetes Federation (IDF) [14].

Statistical analysis was performed using the Statistical Package for Social Sciences, version 20.0 (SPSS Inc., Chicago, IL, USA). For the verification of the normality of the data, the non-parametric Kolmogorov-Smirnov test was used. Because the

Table 1. Variables and cutoff points according to the different classifications for the metabolic syndrome.

Variables	Cook, Weitzman, Auinger, Nguyen, Dietz	De Ferranti, Gauvreau, Ludwig, Neufeld, Newburger, Rifai	IDF
HDL-C	≤ 40 mg/dL	< 50 mg/dL	≤ 40 mg/dL
Blood pressure	≥ P90 age/gender/ height	≥ P90 age/gender/ height	PAS ≥ 130 mmHg ou PAD ≥ 85 mmHg
Glycemia	≥ 110 mg/dL	≥ 110 mg/dL	≥ 100 mg/dL
Waist circunference	≥ P90 age/gender	≥ P75 age/gender	≥ P90 age/gender
Triglycerides	≥ 110 mg/dL	≥ 100 mg/dL	≥ 150 mg/dL

Source: Elaborated by the authors

data did not follow a normal distribution, for the continuous variables, the descriptive analysis was used, using medians and minimum and maximum values (Vmin-Vmax). The comparisons of the measurements were performed by the Mann-Whitney U, according to data distribution. Comparisons of proportions of the categorical variables were performed using the Pearson Chi-square test. The concordance between the results obtained by the different diagnostic criteria was verified by the calculation of the Kappa index. For all tests, statistical significance was set at $p < 0.05$.

The Kappa is an interobserver agreement measure that evaluates the degree of agreement beyond what would be expected to happen only by chance. This measure can vary between -1 and +1, where +1 represents a perfect agreement. The value zero indicates that the agreement was exactly as expected by chance. When the value is less than zero (negative), it indicates that the agreement was smaller than the one expected by chance. Therefore, it suggests discordance, but without being pointed as the intensity of disagreement [15].

In the case of rejection of the hypothesis (Kappa = 0), there is an indication that the measure of agreement is significantly greater than zero, which would indicate the existence of some agreement, not necessarily meaning that it is high.

For this study, the following interpretation was adopted [15] **(Table 2)**

The proportion of agreement was the number of cases in which the two methods agreed (sum of the frequencies of the diagonal) on the total number of cases.

Ethical principles were respected, according to Resolution 466/12 [16], which governs research involving human beings, and the project was approved by the Ethics and Research Committee of the Federal University of Piauí (Opinion: 352.372).

Table 2.

Interpretation	Kappa values
No agreement	<0
Bad agreement	0-0.19
Reasonable agreement	0.20-0.39
Moderate agreement	0.40-0.59
Considerable agreement	0.60-0.79
Almost perfect agreement	0.80-1.00

Results

There was a prevalence of female adolescents; age group of 10 to 14 years old. Although most of the sample was eutrophic, 25.8% and 12.0% of adolescents were overweight and obese, respectively **(Table 3)**.

Increased values of BMI, CC, RCE, IC, PAS, PAD, TG, GJ and decreased HDL-c were observed in adolescents with MS, in the three diagnostic criteria ($p < 0.005$). However, regarding glycemia, no statistically significant differences were detected between the groups (with or without MS) **(Table 4)**.

Table 5 shows the proportion of positive diagnoses for MS, obtained by the different criteria used for its definition. The analysis of the agreement between the criteria showed that in only 7 adolescents, the diagnosis coincided for the three definitions of

Table 3. Clinical characteristics of the researched adolescents. Picos, 2014.

Variables	N	%
Gender		
Male	135	41.5
Female	190	58.5
Age group		
10-14	181	55.7
15-19	144	44.3
Nutritional state		
Extreme thinness	03	0.9
Thinness	11	3.4
Eutrophy	188	57.8
Overweight	84	25.8
Obesity	39	12.0

Source: own authorship.

Table 5. Proportion of subjects regarding risk factors and metabolic syndrome for the three different diagnostic criteria. Picos, 2014.

Variables	Cook, Weitzman, Auinger, Nguyen, Dietz	De Ferranti, Gauvreau, Ludwig, Neufeld, Newburger, Rifai	IDF
	%	%	%
Components			
HDL-C	13.2	63.4	13.2
Blood Pressure	32.0	32.0	8.6
Glycemia	1.2	1.2	1.8
Waist circunference	38.2	54.2	38.2
Triglycerides	17.5	24.9	7.4
Metabolic syndrome	7.7†∓	24.3†‡	3.7‡∓
Number of components			
0	35.4	13.2	48.9
1	36.0	28.3	35.7
2	20.9	34.2	11.7
3	7.1	19.4	2.8
4	0.6	4.9	0.9

Source: own authorship.
†: Kappa = 0.412; p = 0.000; ∓ : Kappa = 0.346; p = 0.000; ‡: Kappa = 0.190; p = 0.000.

Table 4. Values of central tendency and dispersion of clinical and metabolic variables of adolescents, according to presence or absence of metabolic syndrome. Picos, 2014.

‡	SM				
	Present		Absent		p†
	n	Vmin-Vmax	n	Vmin-Vmax	
Cook, Weitzman, Auinger, Nguyen, Dietz					
BMI	23.87	15.02-31.93	20.22	8.67-33.27	0.001
CC	78.20	61.00-100.50	68.95	23.70-102.50	0.000
RCE	0.51	0.38-0.61	0.42	0.15-0.67	0.000
IC	11.83	10.61-14.34	11.17	4.09-17.36	0.000
PAS	120	90-140	108.50	80-160	0.000
PAD	80	60-100	70	50-120	0.000
TG	140.20	43.10-342.90	71.65	31.40-258.60	0.000
GJ	74.60	38.10-118.70	75.10	43.10-113.80	0.633
HDL	41.20	31.80-69.70	48.15	24.10-82.00	0.000
De Ferranti, Gauvreau, Ludwig, Neufeld, Newburger, Rifai					
BMI	22.05	14.75-31.93	19.99	8.67-33.27	0.000
CC	75.00	56.00-102.50	67.60	23.70-93.50	0.000
RCE	0.47	0.35-0.67	0.42	0.15-0.58	0.000
IC	11.68	10.31-17.36	11.09	4.09-13.48	0.000
PAS	110	90-160	106	80-140	0.000
PAD	80	60-120	70	50-94	0.000
TG	111.80	37.30-342.90	69.40	31.40-219.80	0.000
GJ	76.00	38.10-118.70	74.70	43.10-110.80	0.243
HDL	42.90	31.80-69.70	49.35	24.10-82.00	0.000
IDF					
BMI	24.75	15.35-31.93	20.27	8.67-33.27	0.004
CC	84.00	64.00-102.50	69.00	23.70-100.50	0.001
RCE	0.52	0.41-0.67	0.42	0.15-0.61	0.000
IC	12.05	10.61-17.36	11.21	4.09-14.34	0.007
PAS	135	108-160	110	80-140	0.000
PAD	87.50	64-120	70	50-94	0.000
TG	118.90	43.10-253.50	73.50	31.40-342.90	0.021
GJ	79.85	55.40-118.70	75.00	38.10-110.80	0.316
HDL	42.30	37.40-55.10	48.10	24.10-82.00	0.009

Source: own authorship. ‡: Variables, Amounts expressed as median (Vmin-Vmax). †: Mann-Whitney Test.

MS. In the verification of the criteria in pairs, the agreement between IDF and Cook was 92.92% (Kappa=0.346, p=0.000); Between IDF and De Ferranti was 78.76% (Kappa=0.190, p=0.000); and between Cook and De Ferranti was 83.38% (Kappa=0.412, p=0.000). In 50 adolescents, MS was diagnosed exclusively by De Ferranti.

The analysis of FR, separately, showed that De Ferranti presented a significantly higher proportion of positives for MS than the other criteria in HDL-c (p=0.000), CC (p=0.000) and TG (p=0.000). IDF presents a significantly higher proportion of positive for MS than the other two criteria in glycemia and lower in BP (p=0.000) and TG (p=0.000).

Regarding the number of MS components, the high percentage of adolescents with 02 or more altered parameters were highlighted, varying from 15.4% (IDF) to 58.5% (De Ferranti).

Discussion

The detection of adolescents with MS performed prematurely is relevant, recognizing FRs that indicate its presence or greater perspective of its event to stratify the individual´s overall risk to future cardiovascular events [6].

Based on the findings of this study, overweight and obesity were identified in part of the adolescents surveyed. A study carried out with adolescents of the same age group in the city of Viçosa-MG, obtained similar results [17]. These data are worrying, since obesity in adolescence constitutes a serious public health problem, especially because this condition is maintained until adulthood and because it increases the risk for the early manifestation of metabolic complications associated with excess body adiposity.

Increased values of CC, PAS, PAD, TG, GJ and decreased HDL-c, found in adolescents with MS, evaluated by this study, corroborate with the findings of research carried out with a similar population in the city of Campina Grande- PB [18]. These results can be justified by the process of nutritional and behavioral modification of adolescents, whose diets have been specially constituted of foods with high energetic content, emphasizing the high frequency of consumption of processed snacks, processed meats, and sandwiches. In the same conception, sedentarism is another factor probably contributing to the increase in the number of FRC, associated with the etiology of MS, in young individuals.

It is worth noting that the indicators of central obesity, represented by waist circumference (CC), waist/height ratio (RCE) and waist/hip ratio (RCQ), are better predictors of metabolic changes related to cardiovascular risk (CVR) Of Body Mass (BMI) [18].

Regarding the comparison of the diagnostic criteria, the results obtained in this study are very similar to those obtained by a study carried out with adolescents seen at the Child and Adolescent Obesity Clinic of the Hospital das Clínicas of UNICAMP-SP. In both studies, the FR analysis showed that the criteria established by De Ferranti presented a significantly higher proportion of positives for MS than the other criteria in HDL-c, CC, and TG.

Also, the IDF parameters presented a significantly lower proportion of positives for MS than the other two criteria in BP and TG and did not a present statistical difference in GJ values. According to another study [19], altered GJ is rarely observed in children and adolescents, even if they are overweight. This finding was verified in this study, where this variable was the one with the lowest indices for the three criteria.

Conclusion

According to the results obtained in this study, it is possible to observe considerable divergences between the proportions obtained through the three diagnostic criteria, with a greater emphasis on the criteria established by De Ferranti. Thus, it is essential that the scientific community develop a proposal

to evaluate and monitor adolescents, since other research on the subject has had similar outcomes to the study presented here, and this lack of consensus about the diagnostic criteria of MS may jeopardize the elaboration of the diagnosis of MS and the planning of public health actions and policies for the analyzed population.

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