http://dx.doi.org/10.1590/0104-070720180005270016

ANTHROPOMETRIC INDICATORS THAT PREDICT METABOLIC SYNDROME AMONG ADOLESCENTS

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ABSTRACT

Objective: to predict metabolic syndrome among adolescents using anthropometric indicators by analyzing the sensitivity and specificity of cutoff points.

Method: cross-sectional and descriptive study in a stratified sample of 716 adolescents aged from 10 to 19 years old selected by simple random sampling in 30 municipal and state public schools located in Picos, northeast of Brazil. Data were collected from August to December 2014 and March 2015. Body mass index and conicity index were investigated and metabolic syndrome was identified based on criteria adapted for age.

Results: female students were in the majority (61.3%) and the prevalence of metabolic syndrome was 3.2%. The area under the Receiver Operating Characteristic curve revealed that the body mass index and conicity index were efficient to predict metabolic syndrome both in the total sample and stratified by sex.

Conclusion: body mass index and conicity index were good predictors of metabolic syndrome in this population.

DESCRITORES: Adolescent. Metabolic syndrome X. Anthropometric indicators. Risk factors. Obesity.

INDICADORES ANTROPOMÉTRICOS COMO PREDITORES DA SÍNDROME METABÓLICA EM ADOLESCENTES

RESUMO

Objetivo:predizer a síndrome metabólica em adolescentes a partir de indicadores antropométricos por análise de sensibilidade e especificidade dos pontos de corte.

Método: estudo transversal e descritivo em uma amostra estratificada de 716 adolescentes de 10 a 19 anos selecionados por amostragem aleatória simples em 30 escolas públicas municipais e estaduais localizadas em Picos, Piauí, na Região Nordeste do Brasil, a coleta de dados ocorreu no período de agosto a dezembro de 2014 e março de 2015. Investigaram-se os fatores índice de massa corporal e índice de conicidade. A síndrome metabólica foi identificada a partir dos critérios adaptados para a idade.

Resultados: observou-se a prevalência de estudantes do sexo feminino 61,3%, a prevalência de síndrome metabólica foi de 3,2%. A área sobre a curva de Características de Operação do Receptor mostrou que o índice de massa corporal e o índice de conicidade se mostraram eficientes para a predição de síndrome metabólica tanto na amostra total, quanto na estratificação por sexo.

Conclusão: os indicadores antropométricos índice de massa corporal e índice de conicidade foram bons preditores da síndrome metabólica nessa população.

DESCRITORES: Adolescente. Síndrome X metabólica. Indicadores antropométricos. Fatores de risco. Obesidade.

INDICADORES ANTROPOMÉTRICOS COMO PREVISORES DEL SÍNDROME METABÓLICO EN LOS ADOLESCENTES

RESUMEN

Objetivo: prever el síndrome metabólico en adolescentes a partir de indicadores antropométricos por análisis de sensibilidad y especificidad de los puntos de corte.

Método: estudio transversal y descriptivo en una muestra estratificada de 716 adolescentes de 10 a 19 años seleccionados por muestreo aleatorio simple en 30 escuelas públicas, municipales y estatales localizadas en Picos, Piauí, en la Región Noreste del Brasil. La obtención de datos se realizó en el período de Agosto hasta Diciembre del 2014 y en Marzo del 2015. Se investigaron los factores índice de masa corporal y el índice de conicidad. El síndrome metabólico se identificó a partir de los criterios adaptados para la edad.

Resultados: se observó la prevalencia de estudiantes del sexo femenino (61,3%) y la prevalencia del síndrome metabólico fue del 3,2%. El área sobre la curva de Características de Operación del Receptor mostró que el índice de masa corporal y el índice de conicidad se mostraron eficientes para la previsión del síndrome metabólico tanto en la muestra total como en la estratificación por sexo.

Conclusión: los indicadores antropométricos índice de masa corporal e índice de conicidad fueron buenos previsores del síndrome metabólico en esa población**.**

DESCRIPTORES: Adolescente. Síndrome X metabólico. Indicadores antropométricos. Factores de riesgo. Obesidad.

INTRODUCTION

Metabolic syndrome (MS) is a cluster of cardio metabolic conditions and is seen as a complex disorder represented by a set of cardiovascular risk factors usually related to excess fat and insulin resistance.[1] MS is diagnosed when an individual presents at least three of the following risk factors: abdominal obesity, hypertriglyceridemia, low high-density cholesterol (HDL-c), high blood pressure, and abnormal levels of fasting blood glucose.[2]

We have witnessed an increasing number of children and adolescents presenting chronic and metabolic diseases, while MS accounts for 7% of deaths worldwide.[3] In Brazil, its prevalence is 2.6% among adolescents,[4] a fact mainly due to inappropriate diet and physical inactivity, which reveals a need for interventions intended to improve this context and reverse this public health problem during adolescence.[5]

There are various propositions regarding how to establish an MS diagnosis among adolescents. However, there is no consensus regarding the components and respective cut off points for this population, which have already been established for adults.[4]

The greatest concern is the etiology and the determinants of MS because these have not yet been fully understood. What it is known is that it is based on a complex interaction of genetic, metabolic, environmental and behavioral factors, while abdominal obesity is a key component in its occurrence.[6]

Therefore, this study's objective was to predict metabolic syndrome among adolescents based on anthropometric indicators by analyzing the sensitivity and specificity of cut off points.

METHOD

Quantitative and analytical study conducted in 30 municipal and state public schools located in the city of Picos, PI, northeast of Brazil. The population was composed of 5,252 female and male primary school students: 1,452 from municipal schools and 3,800 from state schools. Data were collected from August to December 2014 and in March 2015. Sample size was estimated using a formula for finite populations, considering a confidence interval of 95%, 8% relative error, 4% absolute error, and $t^2_{5\%}$=1.96. The sample resulted in 716 participants stratified in the 30 schools and selected through simple random sampling.

Inclusion criteria were: being regularly enrolled at school and presenting regular attendance; being 10 to 19 years old; and having participated in all the study's stages. Students from whom we could not take anthropometric measures (i.e., pregnant and wheelchair-bound students) and those with a condition or using medication that potentially interfered in glucose or lipid metabolism were excluded. After losses and exclusions were determined, new students were randomly drawn until the number of adolescents estimated for each school was reached.

A structured form addressing personal and socioeconomic info, as well as MS and anthropometric variables, was used.

Anthropometric variables were: body mass index (BMI) and conicity index (CI).

Body mass index was classified according to parameters established for adolescents as proposed by the World Health Organization (WHO)[7] and adopted by the Brazilian Society of Pediatrics (SBP)[8] and the Erica Project.[9]

Weight was verified using a portable body scale with a maximum capacity of 150kg and sensitivity to 100g, with individuals positioned on the center of the equipment, in standing position, wearing light clothes, barefoot, with feet together and arms alongside the body. Height was measured using an inextensible metric tape, with a precision of 0.5cm, perpendicularly fixed on a flat wall. Data were then analyzed and BMI (kg/m^2) was adjusted according to the age and sex of the participants, so that the following nutritional diagnoses were obtained: <Percentile 0.1=Acute slimness, ≥Percentile 0.1 and <Percentile 3=Slim; ≥Percentile 3 and <Percentile 85=Well nourished, ≥Percentile 85 and <Percentile 97=Overweight; ≥Percentile 97 and ≤Percentile 99.9= besity and >Percentile 99.9= Severe Obesity.[7-9]

Waist circumference was measured using an inelastic metric tape placed on the individuals' skin while in an standing position, on the medium point between the last rib and upper border of the iliac crest at the end of a respiratory movement, classified according to the public's age and sex.

CI[10] was calculated as shown in the following equation:

$$\text{C index} = \frac{\text{Waist circumference (m)}}{0.109\sqrt{\dfrac{\text{Body weight (kg)}}{\text{Height (m)}}}}$$

Blood samples were collected to perform biochemical measurements. One day before blood was collected, the students' parents or legal guardians were contacted by phone and reminded of the importance of a 12-hour fast to obtain laboratorial data. The samples were processed on the same day of collection and the serum was analyzed using automatized equipment to determine serum lipid and glycemia serum. Triglycerides, HDL-c and plasma glucose concentrations were determined by enzymatic methods, using BioTécnica® reagents from a laboratory hired specifically for this purpose.

Three or more of the following criteria were used to diagnose MS: triglycerides ≥110 mg/dl, HDL-c ≤40 mg/dl, fast glycemia ≥110mg/dl, systolic or diastolic blood pressure ≥p90 for age, sex and height percentile, and waist circumference ≥p90 for age and sex.[11]

Student's t test for independent measures was initially used to verify correlation among the indicators and MS, with a significance level of $p<0.05$. At this point, all the indicators that presented a significant relationship ($p<0.05$) in constructing a Receiver Operating Characteristic (ROC) curve were selected. To select the cut off points of each of the indicators that identified MS, the ROC curve analysis was adopted.[12]

Briefly, a ROC curve is generated by plotting sensitivity on the y-axis in function of [1 - specificity] on x-axis. Sensitivity refers to the percentage of individuals who presented the outcome (in this study, the outcome was MS) and who were correctly diagnosed through the indicator (i.e., true-positive), while specificity shows the percentage of individuals who did not present the outcome and were correctly diagnosed through the indicator (i.e., true-negative). The criteria used to obtain the cutoff point were the sensitivity and specificity values that were the closest to each other and not lower than 60%.[12]

The cutoff point with the highest specificity and sensitivity was chosen. The area under the ROC curve (AUC) was analyzed. It represents the ability of using the MS score to discriminate between those with and without MS. AUC was considered the likelihood of an randomly selected adolescent to present a MS score that is higher than that obtained by an adolescent randomly selected among individuals without MS. AUC was interpreted according to the following guidelines: test due to chance (AUC=0.5); low precision (0.5<AUC≤0.7); moderate pressure (0.7<AUC≤0.9); high precision (0.9<AUC<1) and perfect discriminatory test (AUC=1).

The statistical significance of each analysis was verified under the ROC curve with a 95% confidence interval (CI95%). In this sense, a perfect indicator presents an area under ROC curve of 1.00, while the diagonal line represents the area under the ROC curve of 0.50. For an indicator to present significant discriminatory ability, the area under the ROC curve is supposed to be between 1.00 and 0.50; the larger the area, the greater the discriminatory power of the respective indicator. A CI95% is another indicator of predictive capacity, so that for an anthropometric indicator to be considered a significant predictor of MS, the lower limit of CI (LL-CI) cannot be <0.50.[12] The statistical analysis of data was conducted using the Statistical Package for Social Science for Windows (SPSS) version 20.0.

The study project was approved by the Institutional Review Project at the Federal University of Piauí (UFPI) (No. 853.499 and CAAE: 16580713.7.0000.5214).

RESULTS

This study was conducted with adolescents from the northeast of Brazil. Most participants were girls (61.3%) aged between 10 and 14 years old (66.8%), 13.44 years old on average (±2.4); half self-reported being of mixed race (50.1%), while 68.9% belonged to economic class C. MS was identified in 3.2% of the sample.

Table 1 - Metabolic syndrome and anthropometric indicators among adolescents. Picos, PI, Brazil, 2015

Indicators, mean (standard deviation)	Metabolic syndrome		p-value*
	Yes	No	
Total sample			
Body mass index	26.97 (4.70)	18.76 (3.51)	0.000†
Conicity index	1.25 (0.055)	1.14 (0.062)	0.000†
Girls			
Body mass index	26.08 (5.27)	19.51 (4.01)	0.000†
Conicity index	1.22 (0.04)	1.1 (0.06)	0.000†
Boys			
Body mass index	26.97 (4.70)	18.76 (3.51)	0.000†
Conicity index	1.27 (0.05)	1.16 (0.060)	0.000†

† $p \leq 0.001$; *Student's T test.

A significant correlation was found between BMI, CI and MS both in the total sample and when individuals were stratified by sex (Table 1). Adolescents with MS presented the highest means, BMI and CI when compared to those who did not have MS.

When the total sample was assessed, the analysis of the ROC curve (Figure 1) indicated moderate precision of BMI and high precision of CI, verified by AUC of 0.892 (CI95%) and AUC of 0.908 (CI95%), respectively.

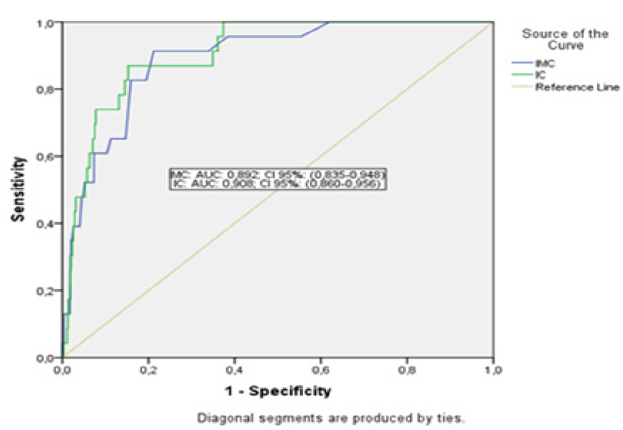

Figure 1 – Receiver Operating Characteristic Curve of the predictors body mass index and conicity index to diagnose metabolic syndrome among 10 to 19 year-old female and male adolescents

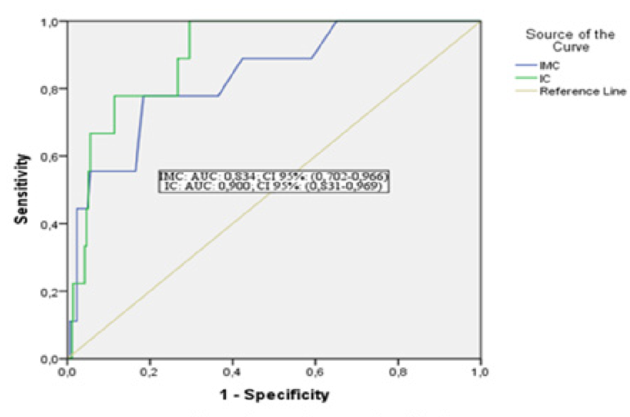

Figure 2 – Curve of Characteristics of Receiver Operation of the predictors body mass index and conicity index to diagnose metabolic syndrome among 10 to 19-year old female adolescents

Analysis of the ROC curve concerning the female adolescents (Figure 2) indicated moderate precision of BMI and CI, verified by AUC of 0.834 (CI95%) and AUC of 0.900 (CI95%), respectively.

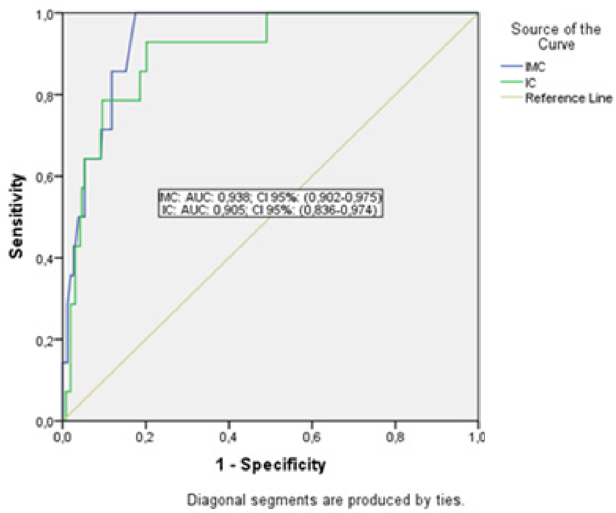

Figure 3 – Curve of Characteristics of Receiver Operation of the predictors body mass index and conicity index to diagnose metabolic syndrome among 10 to 19-year old male adolescents

The analysis of the ROC curve concerning the male adolescents (Figure 3) indicated high precision of BMI and CI, verified by AUC of 0.938 (CI95%) and AUC of 0.905 (CI95%), respectively.

Table 2 - Cut off points, sensitivity and specificity of anthropometric indicators predicting MS in the sample. Picos, PI, Brazil, 2015

Metabolic syndrome	Cutoff point	Sensitivity (%)	Specificity (%)
Total sample			
Body mass index	22.99	82.6	84.1
Conicity index	1.20	87.0	84.7
Girls			
Body mass index	22.97	77.8	81.6
Conicity index	1.20	77.8	88.6
Boys			
Body mass index	22.99	85.7	88.2
Conicity index	1.21	85.7	81.4

The points of the indicators proposed in this study with the power to predict MS that presented the greatest sensitivity and specificity were considered cut off points and are presented in Table 2. In regard to the total sample, the points with the greatest sensitivity and specificity were: 22.99 Kg/m^2 for BMI; 1.20 for CI (sensitivity and specificity greater >60%).

The cutoff points considered for the girls were: 22.97 Kg/m^2 for BMI; 1.20 for CI and for the boys: 22.99 Kg/m^2 for BMI and 1.21 for CI.

DISCUSSION

The prevalence of MS found in the population addressed here was 3.2%, that is, greater than the prevalence reported by Brazilian studies.[4-13]

The heterogeneity of definitions and cut off points for the MS components may explain, at least in part, the different prevalence rates reported in the literature, although the prevalence of this condition has increased both in developed and developing countries.[14]

The profile of the adolescents reveals most were girls, which is in agreement with studies reporting that a female public is most frequently found in this investigations.[15-17]

In regard to excess weight, a significant correlation was found between BMI, CI and MS. The literature shows that waist circumference together with excess weight is a risk factor among adolescents for the development of metabolic and cardiovascular alterations, and these are good predictors for the emergence of MS.[18-19]

It is known that excess weight may predispose changes that favor the emergence of MS. One study conducted in Guabiruba, SC, Brazil with 1,011 students reports that obese students presented the most abnormal parameters concerning HDL-c, hypertriglyceridemia and BP.[20]

Another variable used to measure scores was the conicity index. It mainly assesses central obesity and is often used among adults because it is frequently associated with cardiovascular diseases. In this study, the CI showed good sensitivity and specificity when predicting MS among adolescents. It is known that excess body fat around the waist is related to metabolic disorders and is strongly associated with MS among adolescents.[21]

The ROC curve was used to establish the cut off points of sensitivity and specificity for the emergence of MS among adolescents. The ROC curve has been widely used in epidemiological studies to determine cut off points of anthropometric indicators to predict MS. This type of analysis not only enables the identification of the best cut off point but also provides the area under the curve that reveals an indicator's discriminating power for a given outcome.[22] In this study, the ROC curve showed that BMI and CI were good predictors of MS for the population under study.

These results show that body fat, especially around the abdominal area, is related to MS, as reported by other studies showing that abdominal fat is a superior measure when detecting cardiovascular risk and metabolic disorders among adolescents; thus, it is a good predictor of MS.[22-23]

Note that an excessive increase in body fat, regardless of where it is stored, may disrupt the metabolism of carbohydrates and lipids, as well as lead to exaggerated production of factors that potentiate MS.[22]

Excess weight is a factor that predisposes the emergence of insulin resistance and MS among adolescents, a condition that may persist into adulthood. Therefore, preventive measures intended to minimize and avoid the occurrence of cardiovascular diseases later in life are needed.[13,24-25]

Strategies such as nutritional education and exercise intended to decrease risk factors are efficacious interventions to reverse this condition.[18-19]

Therefore, more important than adding criteria to diagnose cardio metabolic diseases is investment in health education and preventive measures and encouraging good eating habits, together with the regular practice of physical activity. We stress the importance of early intervention, even during childhood, to prevent complications over the long term, preferably working in schools, which is where children spend most of their time and because schools can contribute to the exchange of experiences and promote the adoption of good practices.

CONCLUSION

The conclusion is that the anthropometric indicators BMI and CI were good predictors of MS. Those students with MS presented the highest means of these parameters when compared to the group without the syndrome.

Note that the early onset of excess weight among adolescents is a factor that causes concern. Thus, educational strategies implemented in a school context, promoting healthy habits such as a diet rich in fruits and vegetables together with regular exercise, are essential.

The incorporation of good habits, autonomy and an attitude promoting the modification of habits, starting early in adolescence, should be encouraged because this is a phase when individuals are building their personalities and values and are more likely to acquire good habits, preventing potential health complications.

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Received: February 21, 2017
Approved: June 07, 2017