

Metabolic Syndrome and Importance of Associated Variables in Children and Adolescents in Guabiruba - SC, Brazil

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Abstract

Background: The risk factors that characterize metabolic syndrome (MetS) may be present in childhood and adolescence, increasing the risk of cardiovascular disease in adulthood.

Objectives: Evaluate the prevalence of MetS and the importance of its associated variables, including insulin resistance (IR), in children and adolescents in the city of Guabiruba-SC, Brazil.

Methods: Cross-sectional study with 1011 students (6–14 years, 52.4% girls, 58.5% children). Blood samples were collected for measurement of biochemical parameters by routine laboratory methods. IR was estimated by the HOMA-IR index, and weight, height, waist circumference and blood pressure were determined. Multivariate logistic regression models were used to examine the associations between risk variables and MetS.

Results: The prevalence of MetS, IR, overweight and obesity in the cohort were 14%, 8.5%, 21% and 13%, respectively. Among students with MetS, 27% had IR, 33% were overweight, 45.5% were obese and 22% were eutrophic. IR was more common in overweight (48%) and obese (41%) students when compared with eutrophic individuals (11%; $p = 0.034$). The variables with greatest influence on the development of MetS were obesity (OR = 32.7), overweight (OR = 6.1), IR (OR = 4.4; $p \leq 0.0001$ for all) and age (OR = 1.15; $p = 0.014$).

Conclusion: There was a high prevalence of MetS in children and adolescents evaluated in this study. Students who were obese, overweight or insulin resistant had higher chances of developing the syndrome. (Arq Bras Cardiol. 2015; 105(1):37-44)

Keywords: Metabolic Syndrome; Insulin Resistance; Students; Risk Factors; Overweight.

Introduction

Metabolic syndrome (MetS) is characterized by a set of cardiometabolic risk factors that include abdominal obesity, hypertension, hypertriglyceridemia, hyperglycemia and decreased serum concentration of high-density lipoprotein cholesterol (HDL-c)^{1,2}. There is a strong association between MetS and other metabolic variables which may be precursors of the syndrome, such as insulin resistance (IR), overweight and obesity^{3,4}. In children and adolescents, MetS is a controversial and still inconclusive topic, mainly due to lack of unified criteria regarding the variables that characterize the syndrome and the cut-off values of these variables. In addition, the definition of MetS, as described in an elegant review by Damiani et al.⁵, does not necessarily identify which components are abnormal in the individual to allow a better treatment. In any case, there is a consensus that the identification of MetS in children and

adolescents indicates without any doubt the presence of a set of factors and/or clinical and metabolic variables that increase the risk of development of type 2 diabetes mellitus and cardiovascular diseases (CVDs)⁵.

The prevalence of MetS in this population is growing in parallel to the increase in juvenile obesity⁶. According to systematic reviews, the prevalence of MetS in a general population of children and adolescents worldwide⁷ and in Brazil⁸ is 3.3% (0–19.2%) and 11.9% (2.8–29.3%), respectively, and in children with overweight and obesity, the prevalence is 29.2% (10–66%). Overall, the prevalence of IR is not well established. However, in overweight⁸ and obese^{8,9} children and adolescents, the prevalence of IR ranges from 0 to 24% and 4.4 to 57%, respectively. Based on the results of more recent studies, 33.2%¹⁰ and 41.3%¹¹ of obese children and adolescents have IR.

The several risk factors of the syndrome when present during childhood can persist or become more evident from adolescence to adulthood¹². Thus, it is important to identify these risk factors early to intervene and minimize future metabolic changes. Therefore, the aim of this study was to verify the prevalence of MetS in students in Guabiruba-SC, as well as the prevalence of IR, obesity and overweight and the association of each of these variables with the development of the syndrome.

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Methods

Cross-sectional study with 1011 students self-reported Caucasians, attending elementary school (1st to 8th grades), aged between six and 14 years and representing 44.0% of the students enrolled in municipal and state schools in the city of Guabiruba-SC (Brazil) in 2009. All 12 schools in the city were represented in this study and each had participation of 21 to 100% of their students. The minimum sample size required to detect statistically significant differences ($\alpha < 0.05$) was calculated considering a power of 80% ($1 - \beta$) and a prevalence of abdominal obesity of 26.9% in adolescents in the city of Florianópolis¹³, capital of the state of Santa Catarina, with an acceptable error of 2.5% of the estimate and a 20% increase in the minimum calculated value to account for eventual losses. Thus, we estimated that the minimum number of students to be evaluated was 1005. For the IR analysis, we considered the prevalence of 41.3%¹⁴, with an acceptable error of 4% of this estimate and a 20% increase in the minimum calculated size to account for eventual losses, totaling a minimum of 557 students. The study included a voluntary or accessible convenience sample non-randomly selected, and was approved by the Ethics Committee for Human Subjects at the *Universidade Federal de Santa Catarina* (No. 210/2009). All participants presented an Informed Consent Form (CNS Resolution 196/96/MetS) signed by their parents or legal guardians.

Blood samples were obtained after 12- to 14-hour fasting and the biochemical parameters glucose, total cholesterol (TC), HDL-c and triglycerides (TG) were measured by an enzymatic method on an automated analyzer (BTS 370 BioSystems, Connecticut - USA). Low-density lipoprotein cholesterol (LDL-c) was estimated by the Friedewald equation¹⁴. Serum insulin was measured in 667 samples by chemiluminescence immunometric assay with labeled enzyme in solid phase using the reagent system Immulite 2000 systems® (Siemens Healthcare Diagnostics, Newark, USA). IR was estimated with the HOMA-IR (homeostatic model assessment of insulin resistance) index: (HOMA-IR = fasting serum insulin [$\mu\text{U/mL}$] x fasting serum glucose [mg/dL]/405)¹⁵. The cut-off value adopted was > 3.16 ¹⁶.

Weight and height were measured with equipment consisting of a scale with weighing capacity of 200 kg and accurate to 100 g, and a stadiometer with a height range of 2.0 m and accurate to 0.5 cm (Welmy, São Paulo-SP). Body mass index (BMI) was estimated according to the formula (BMI = Weight [kg]/Height [m^2]) and the z-score values for BMI according to age were calculated with the World Health Organization (WHO) software AnthroPlus¹⁷. Results > 1 and 2 standard deviations (SDs) above the BMI-for-age z-score were defined as overweight and obesity, respectively¹⁷.

Waist circumference (WC) was determined at the narrowest measurement between the lower rib and the upper border of the iliac crest with a flexible and inelastic measuring tape, as described by Taylor et al.¹⁸. Blood pressure (BP) was measured by oscillometry with a cuff and a sphygmomanometer according to the I Guideline for Prevention of Atherosclerosis in Childhood and Adolescence¹⁶.

The criteria used for diagnosis of MetS were those described by the National Cholesterol Education Program Adult

Treatment Panel III¹, using the cut-off values for children and adolescents of the I Guideline for Prevention of Atherosclerosis in Childhood and Adolescence¹⁶. The diagnosis of MetS was established in the presence of at least three of the following variables: increased WC for gender and age, according to Taylor et al.¹⁸, TG ≥ 100.0 mg/dL, HDL-c ≤ 45.0 mg/dL, fasting glucose ≥ 100.0 mg/dL, and BP ≥ 90 percentile for gender, age and height.

Statistical analysis

Categorical results are presented as absolute frequency and percentage, and quantitative results as median and interquartile range. We used the chi-square test (χ^2) to detect differences in prevalence between students with and without MetS, boys and girls, and children and adolescents. Quantitative differences between the groups were detected by the Mann-Whitney test after application of the Kolmogorov-Smirnov normality test. Multivariate logistic regression estimated the effect of the independent variables gender, age, IR, overweight and obesity in the clinical outcome of interest (concomitant presentation of at least three factors consistent with MetS). Adjusted odds ratio (aOR) with a 95% confidence interval (95% CI) was used to estimate this association. The adequacy of the model was analyzed by the chi-square and Hosmer-Lemeshow tests, and by the area under the ROC curve¹⁹. All analyses were performed with *MedCalc® Statistical Software, version 14.12.0* (MedCalc Software, Ostend, Belgium), and p values < 0.05 were considered statistically significant.

Results

A total of 1011 Caucasian, volunteering students participated in the study, 52.4% of which were girls, 58.5% children and 41.5% adolescents. The results of the biochemical, anthropometric and clinical characteristics of the cohort are shown in Table 1. The overall prevalence of MetS was 14.1%, whereas the prevalence of overweight, obesity and IR were 21.1%, 13.2% and 8.5%, respectively. However, in students with MetS these prevalences increased to 32.9%, 45.5% and 27.0%, respectively ($p \leq 0.0003$). As expected, students with MetS had lower serum concentrations of HDL-c and higher concentrations of TG, glucose and insulin, in addition to increase in WC, systolic and diastolic BP and HOMA-IR index when compared with those without MetS ($p < 0.0001$). In contrast, there were no differences in CT and LDL-c (Table 1).

The prevalence of MetS was similar in boys and girls (Table 2), but was higher in adolescents (19.1%) when compared with children (10.6%; $p < 0.0001$; Table 3). In general, the most frequent components of MetS and its associated variables were, in descending order, low HDL-c (91.6%), abdominal obesity (85.3%), hypertriglyceridemia (76.9%) obesity (45.5%), high BP (46.1%), hyperglycemia (35.7%), overweight (32.9%) and IR (27.0%). There was no difference between genders or between children and adolescents, with the exception of obesity and IR which were more frequent, respectively, in boys and girls (Table 2), high BP and IR, which were more common in adolescents, and obesity, which was more prevalent in children (Table 3).

Table 1 – Biodemographic, clinical and biochemical characteristics of children and adolescents (6–14 years) evaluated in the city of Guabiruba-SC, Brazil, 2011

| Variables | General n = 1011 | With MetS n = 143 (14.1%) | Without MetS n = 868 (85.9%) | p |
|--------------------------|---------------------|------------------------------|---------------------------------|----------|
| BMI (kg/m ²) | 17.8 (11.3-32.7) | 21.1 (14.3-32.7) | 17.3 (11.3-33.7) | 0.0001 |
| WC (cm) | 64.5 (58.0-73.0) | 80.0 (71.0-85.8) | 63.0 (57.0-70.0) | 0.0001 |
| Abdominal obesity n (%) | 307 (30.4) | 122 (85.3) | 185 (21.3) | < 0.0001 |
| Eutrophy n (%) | 582 (57.6) | 31 (21.7) | 551 (63.5) | 0.0001 |
| Overweight n (%) | 213 (21.1) | 47 (32.9) | 166 (19.1) | 0.0003 |
| Obesity n (%) | 133 (13.2) | 65 (45.5) | 68 (7.8) | < 0.0001 |
| SBP (mmHg) | 100.0 (90.0-110.0) | 110.0 (100.0-120.0) | 100.0 (90.0-110.0) | 0.0001 |
| DBP (mmHg) | 60.0 (50.0-70.0) | 70.0 (60.0-80.0) | 60.0 (50.0-70.0) | 0.0001 |
| TC (mg/dL) | 168.0 (150.9-187.6) | 170.3 (154.1-188.4) | 167.7 (150.5-187.6) | 0.3092 |
| LDL-c (mg/dL) | 102.4 (85.6-120.1) | 106.3 (86.0-123.5) | 102.1 (85.4-119.1) | 0.2039 |
| HDL-c (mg/dL) | 47.9 (42.0-55.7) | 40.8 (36.3-43.5) | 49.6 (43.9-56.9) | 0.0001 |
| TG (mg/dL) | 77.6 (60.9-100.7) | 120.4 (100.3-158.2) | 73.8 (58.4-91.1) | 0.0001 |
| Glucose (mg/dL) | 90.2 (85.0-95.2) | 95.7 (89.3-101.0) | 90.0 (84.5-94.9) | 0.0001 |
| | n = 667 | n = 100 | n = 567 | |
| Insulin (U/L) | 4.50 (2.40-8.40) | 7.91 (4.69-13.8) | 3.80 (2.30-7.22) | 0.0001 |
| HOMA-IR | 0.99 (0.54-1.96) | 1.91 (1.07-3.36) | 0.86 (0.52-1.66) | 0.0001 |
| IR n (%) | 57 (8.5) | 27 (27.0) | 30 (5.3) | < 0.0001 |

Results are expressed as median (interquartile range) for continuous variables and absolute value and percentage for categorical variables. MetS: metabolic syndrome; BMI: body mass index; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; Low-density lipoprotein cholesterol; HDL-c: high-density lipoprotein cholesterol; TG: triglycerides; HOMA-IR: homeostatic model assessment of insulin resistance; IR: insulin resistance.

Table 2 – Prevalence (%) of variables associated with metabolic syndrome in children and adolescents (6–14 years) evaluated in the city of Guabiruba-SC, Brazil, 2011

| Variables n (%) | With MetS | | | p | Without MetS | | | p |
|-----------------|--------------------|------------------------|-------------------------|--------|-------------------------|-------------------------|--------------------------|--------|
| | General n = 143 | Boys n = 63 (44.1%) | Girls n = 80 (55.9%) | | General n = 868 | Boys n = 418 (48.2%) | Girls n = 450 (51.8%) | |
| Low HDL-c | 131 (91.6) | 56 (88.9) | 75 (93.7) | 0.4396 | 249 (28.7) [†] | 127 (30.4) | 122 (27.1) | 0.3178 |
| HyperTG | 110 (76.9) | 48 (76.2) | 61 (76.2) | 0.8432 | 154 (17.8) [†] | 65 (15.6) | 89 (19.8) | 0.1264 |
| Hyperglycemia | 51 (35.7) | 28 (44.4) | 23 (28.7) | 0.0766 | 66 (7.6) [†] | 44 (10.5) | 22 (4.9) | 0.0029 |
| High BP | 66 (46.1) | 24 (38.1) | 42 (52.5) | 0.1221 | 71 (8.2) [†] | 44 (10.5) | 27 (6.0) | 0.0217 |
| Increased WC | 122 (85.3) | 53 (84.1) | 69 (86.2) | 0.9091 | 185 (21.3) [†] | 74 (17.7) | 111 (24.7) | 0.0150 |
| Overweight | 47 (32.9) | 17 (27.0) | 30 (37.5) | 0.2511 | 166 (39.7) | 81 (19.4) | 85 (18.9) | 0.9197 |
| Obesity | 65 (45.5) | 35 (55.5) | 30 (37.5) | 0.0480 | 68 (7.8) [†] | 37 (8.8) | 31 (6.9) | 0.3599 |
| | n = 100 | n = 41 | n = 59 | | n = 567 | n = 267 | n = 300 | |
| IR | 27 (27%) | 4 (9.7) | 23 (39.0) | 0.0025 | 30 (5.3) [†] | 7 (2.6) | 23 (7.7) | 0.0118 |

[†] P < 0.0001 compared with students with metabolic syndrome (chi-square test with Yates' correction). MetS: metabolic syndrome; HDL-c: high-density lipoprotein cholesterol (≤ 45 mg/dL); HyperTG: hypertriglyceridemia (≥ 100 mg/dL); Hyperglycemia (≥ 100 mg/dL); WC: waist circumference (≥ p90); BP: blood pressure (≥ p90); IR: insulin resistance (HOMA-IR > 3.16).

In students without MetS, the prevalences of hyperglycemia and high BP were higher in boys, whereas increased WC and IR were more frequent in girls. As for age, the prevalence of

low HDL-c (32.7%), hyperglycemia (10.9%), increased BP (10.6%) and IR (10.3%) were higher in adolescents when compared with children (Table 3).

Table 3 – Prevalence of variables associated with metabolic syndrome (MetS) in children (6–10 years) and adolescents (11–14 years) with and without MetS evaluated in the city of Guabiruba-SC, Brazil, 2011

| Variables | Children n = 592 | | p < 0.0001 | Adolescents n = 419 | | p < 0.0001 | Children vs. Adolescents | |
|---------------|-----------------------------|---------------------------------|------------|-----------------------------|---------------------------------|------------|--------------------------|------------------------|
| | With MetS n = 63 (10.6%) | Without MetS n = 529 (89.4%) | | With MetS n = 80 (19.1%) | Without MetS n = 339 (80.9%) | | With MetS 0.0001 | Without MetS 0.0002 |
| Low HDL-c | 57 (90.5) | 138 (26.1) | < 0.0001 | 74 (92.5) | 111 (32.7) | < 0.0001 | 0.9009 | 0.0433 |
| HyperTG | 47 (74.6) | 99 (18.7) | < 0.0001 | 63 (78.7) | 55 (16.2) | < 0.0001 | 0.7057 | 0.3954 |
| Hyperglycemia | 19 (30.1) | 29 (5.5) | < 0.0001 | 32 (40.0) | 37 (10.9) | < 0.0001 | 0.2931 | 0.0052 |
| High BP | 22 (34.9) | 35 (6.6) | < 0.0001 | 44 (55.0) | 36 (10.6) | < 0.0001 | 0.0261 | 0.0485 |
| Increased WC | 56 (88.9) | 107 (20.2) | < 0.0001 | 66 (82.5) | 78 (23.0) | < 0.0001 | 0.4034 | 0.3691 |
| Overweight | 16 (25.4) | 93 (17.6) | 0.1811 | 31 (38.7) | 73 (21.5) | 0.0022 | 0.1331 | 0.1812 |
| Obesity | 39 (61.9) | 46 (8.7) | < 0.0001 | 26 (32.5) | 22 (6.5) | < 0.0001 | 0.0008 | 0.2951 |
| | n = 50 | n = 382 | | n = 50 | n = 185 | | | |
| IR | 5 (10.0) | 11 (2.9) | 0.0360 | 22 (44.0) | 19 (10.3) | < 0.0001 | < 0.0001 | 0.0005 |

HDL-c: high-density lipoprotein cholesterol (≤ 45 mg/dL); HiperTG: hypertriglyceridemia (≥ 100 mg/dL); Hyperglycemia (≥ 100 mg/dL); WC: waist circumference ($\geq p90$); BP: blood pressure ($\geq p90$); IR: insulin resistance (HOMA-IR > 3.16).

The prevalence of several MetS components present simultaneously in students with and without MetS is presented in Table 4. Among children and adolescents with MetS, 68.5%, 27.3% and 4.2% showed three, four and all five metabolic variables of the syndrome, respectively, without significant differences between boys and girls. Among the 27 students with MetS and IR, 12 (44.4%) had three abnormal variables for MetS, whereas 12 (44.4%) and three (11.1%) students had four and five abnormal variables, respectively. In children and adolescents without MetS, 38.2% and 22.3% had one or two abnormal MetS variables, respectively, with 46.7% and 26.7% of these, respectively, presenting IR (Table 4).

The general prevalence of IR was not associated with the nutritional status of the cohort, with 38.6% of the eutrophic, 35.1% of the overweight and 24.6% of the obese students showing IR ($p = 0.1597$; Table 5). However, after stratification of the prevalence of IR according to the occurrence of MetS and nutritional status, there was a higher proportion of overweight (48.1%) and obese (40.7%) students with MetS and IR compared with eutrophic students (11.1%, $p = 0.034$). In students without MetS, in contrast, IR was more common in eutrophic individuals (63.3%) than in those with overweight (23.3%) or obesity (10.0%, $p = 0.0001$; Table 5).

Results of aOR obtained by multivariate logistic regression analysis are shown in Table 6. The prediction of MetS in the children and adolescents evaluated in the study was significantly increased for age (aOR 1.15; $p = 0.0142$), IR (aOR, 4.39; $p = 0.0001$), overweight (aOR 6.09; $p < 0.0001$), and, mainly, obesity (aOR 32.68; $p < 0.0001$). In a logistic regression model adjusted for gender and considering the HOMA-IR index as an independent variable, the increase in each HOMA-IR unit was associated with MetS, with an OR of 1.25 (95% CI 1.09–1.44; $p = 0.0220$).

Discussion

The occurrence of MetS in children and adolescents must be identified early to allow risk stratification of future cardiovascular

events¹. In the present study, 14.1% of the students assessed in the city of Guabiruba-SC were diagnosed with MetS, especially those with overweight or obesity, IR and adolescents. It is worth mentioning that among patients with MetS, 22% were eutrophic. Compared with other Brazilian studies that used identical classification criteria, the prevalence of MetS found in our cohort was higher than that observed in Maracá-SP (3.6%)²⁰, but lower than those described in Salvador-BA (17.7%)²¹ and Feira de Santana-BA (22.6%)²², probably due to the different proportions of obese individuals in each of these cohorts.

MetS in children and adolescents is becoming a global public health concern²³. This syndrome has a complex and multifactorial etiology and the control of its modifiable risk factors during the prenatal period and/or childhood may have a long-term effect on the prevention of chronic degenerative diseases, including CVDs. Considering the growing evidence on the progression of risk factors from childhood to adulthood, the potential role of genetic, prenatal, environmental, biological and behavioral determinants on childhood MetS should be emphasized^{24, 25}. In this context, MetS in children is related mainly to "globesity", a term used by WHO to emphasize the increasing global epidemic of juvenile overweight and obesity. In the present study conducted with children and adolescents in a semirural city in Santa Catarina, we found a high prevalence of students with overweight (21%) and obesity (13%), with great chance of developing MetS (6.1 and 32.7 times, respectively). Among students with MetS, 33% were overweight and 45.5% were obese. Similar results were reported in obese children and adolescents in Maracá-SP²⁰, obese adolescents in Porto Alegre-RS²⁶ and in three cities in Paraná²⁷. In obese children in Taguatinga-DF, the prevalence of MetS was 16.7%²⁸.

It is common knowledge that obesity in children and adolescents is associated with the occurrence of other components of MetS and IR²⁹. Similarly, there is a strong association between IR and MetS or cardiometabolic risk variables^{10,11,28}. In this study, 35% and 25% of the students with overweight and obesity, respectively, were resistant to

Table 4 – Prevalence (%) of one or more simultaneous variables associated with metabolic syndrome in children and adolescents (6–14 years) evaluated in the city of Guabiruba-SC, Brazil, 2011

| With MetS | General (n = 143) | Boys (n = 63) | Girls (n = 80) | P |
|----------------------|------------------------------|---------------------------|----------------------------|--------|
| Variables (n) | n (%) | n (%) | n (%) | |
| Three | 98 (68.5) | 45 (71.4) | 53 (66.2) | 0.6289 |
| Four | 39 (27.3) | 15 (23.8) | 24 (30.0) | 0.5239 |
| Five | 06 (4.2) | 03 (4.8) | 03 (3.7) | 0.9247 |
| IR | (n = 27) | (n = 4) | (n = 23) | |
| Three + IR | 12 (44.4) | 0 | 12 (52.2) | 0.1633 |
| Four + IR | 12 (44.4) | 02 (50.0) | 10 (43.5) | 0.7614 |
| Five + IR | 03 (11.1) | 02 (50.0) | 01 (4.4) | 0.0698 |
| Without MetS | General (n = 868) | Boys (n = 418) | Girls (n = 450) | |
| One | 332 (38.2) | 159 (38.0) | 173 (38.4) | 0.9591 |
| Two | 194 (22.3) | 96 (23.0) | 98 (21.8) | 0.7321 |
| IR | (n = 30) | (n = 7) | (n = 23) | |
| One + IR | 14 (46.7) | 3 (42.9) | 11 (47.8) | 0.8375 |
| Two + IR | 8 (26.7) | 3 (42.9) | 5 (21.7) | 0.5335 |

MetS: metabolic syndrome; IR: insulin resistance.

Table 5 – Prevalence (%) of insulin resistance (IR) in children and adolescents (6–14 years) with and without metabolic syndrome evaluated in the city of Guabiruba-SC, Brazil, 2011

| | Adolescents n = 667 | | With MetS n = 100 | | Without MetS n = 567 | | P |
|----------------------------|-------------------------|------------------------|------------------------|--------|-------------------------|---------------------------|--------|
| | IR (+) n = 57 (8.5%) | IR (+) n = 27 (27%) | IR (-) n = 73 (73%) | P | IR (+) n = 30 (5.3%) | IR (-) n = 537 (94.7%) | |
| Nutritional Status | n (%) | n (%) | n (%) | | n (%) | n (%) | |
| Low weight n = 54 (8.5%) | 1 (1.7) | 0 (0.0) | 0 (0.0) | --- | 1 (3.3) | 53 (9.9) | 0.3800 |
| Eutrophy n = 379 (56.8%) | 22 (38.6) | 3 (11.1) | 15 (20.5) | 0.4380 | 19 (63.3) | 342 (63.7) | 0.8802 |
| Overweight n = 147 (22.0%) | 20 (35.1) | 13 (48.1) | 21 (28.8) | 0.1215 | 7 (23.3) | 106 (19.7) | 0.8059 |
| Obesity n = 87 (13.0%) | 14 (24.6) | 11 (40.7) | 37 (50.7) | 0.5158 | 3 (10.0) | 36 (6.7) | 0.7456 |
| P (Eutrophy vs. Obesity) | 0.1597 | 0.0340 | 0.0002 | | 0.0001 | < 0.0001 | |

MetS: metabolic syndrome; IR (+): presence of insulin resistance; IR (-): absence of insulin resistance.

Table 6 – Predictors of metabolic syndrome in children and adolescents (6–14 years) evaluated in the city of Guabiruba-SC, Brazil, 2011, estimated with multivariate logistic regression

| Variables | aOR | 95% CI | p |
|-------------|-------|-------------|----------|
| Age | 1.15 | 1.03-1.28 | 0.0142 |
| Male gender | 0.77 | 0.45-1.31 | 0.3389 |
| Overweight | 6.09 | 3.25-11.42 | < 0.0001 |
| Obesity | 32.68 | 16.51-64.69 | < 0.0001 |
| IR | 4.39 | 2.14-9.00 | 0.0001 |

aOR: adjusted odds ratio; 95% CI, 95% confidence interval; IR: insulin resistance.

insulin. IR has been considered a potential cardiovascular risk marker^{10,11} and was present in 33% and 41% of the obese adolescents treated at a specialized outpatient clinic in Osasco-SP¹⁰ and by the Unified Health System in Campina Grande-PB¹¹, respectively, 39.4% of the obese children and adolescents evaluated in Bolivia³⁰ and 7.7% of the obese children (3–5 years) evaluated in northern Netherlands³¹. In our study, IR had an overall prevalence of 8.5% in the evaluated cohort, and was present mainly in girls and adolescents. In students with MetS, the prevalence of IR increased to 27%, mainly in overweight (48%) and obese (41%) individuals, and was also more frequent in girls (39%) and adolescents (44%), thus confirming the association with overweight and some hormonal influence^{28,32-35}. On logistic regression analysis in our study, IR was associated with MetS (aOR = 4.4), with a 25% increase in the risk of MetS (aOR = 1.25) for each HOMA-IR unit increase. In general, our results corroborate the findings of Medeiros et al.¹¹, who reported that girls and adolescents with MetS and IR had a high risk of presenting MetS components. Other Brazilian authors also reported important and significant associations between IR and several clinical and metabolic abnormalities compatible with MetS in obese adolescents¹⁰ and children^{28,36,37}.

According to Bradshaw et al.³⁸, a substantial number of children and adolescents has some of the MetS components. In fact, our results are a cause of concern and deserve attention, as 38% and 22% of the students without MetS had one or two components of the syndrome. Furthermore, 29% of these individuals had low HDL-c, 21% had abdominal obesity – which represents a greater risk for CVDs³⁹ – and 63% were resistant to insulin, indicating a high percentage of young individuals with high probability of future worsening in cardiometabolic risks. In students with MetS, there was also a high proportion of individuals with up to four components of the syndrome (27%), 44% of which were IR. It also draws attention the fact that 4.2% of the students had five metabolic abnormalities including IR, which is unusual in children and adolescents. In general, these results are comparable to those of other Brazilian studies^{10,11,26,36,40}. The variables of greatest frequency were low HDL-c, abdominal obesity, hypertriglyceridemia and high BP, with prevalences of 92%, 85%, 77% and 46%, respectively. It is worth noting that in obese children³¹ and adolescents²⁶, high BP tends to be more prevalent than lipid abnormalities.

Since this study has a cross-sectional design, it has limitations in defining temporal causal relationships. In addition to that, the fact that these results cannot be extrapolated to the general population of children and adolescents in the city of Guabiruba-SC may also be

considered a limitation. Other limitations include the absence of insulin measurement in all students, lack of evaluation of eating habits, physical activity level and extent of pubertal maturation, and absence of family history for cardiovascular disease, obesity and diabetes mellitus.

Conclusions

In summary, the population of children and adolescents who participated in the present study showed a high prevalence of MetS, particularly students with obesity or overweight, those with IR and adolescents. Low HDL-c was the most frequent component of the syndrome, followed by abdominal obesity and hypertriglyceridemia. Furthermore, we confirmed that obesity, overweight, IR and age were the associated variables most frequently associated with MetS.

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Authors' Contributions

Conception and design of the research: Rosini N, Moura SAZO, Rosini RD, Silva EL. Data collection: Rosini N, Moura SAZO, Rosini RD. Data analysis and interpretation: Rosini N, Moura SAZO, Rosini RD, Machado MJ, Silva EL. Statistical analysis: Machado MJ, Silva EL. Manuscript writing: Rosini N, Machado MJ, Silva EL. Critical review of the intellectual content of the manuscript: Rosini N, Moura SAZO, Rosini RD, Machado MJ, Silva EL.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

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