Prevalence of metabolic syndrome in children aged 5-9 years from southwest colombia: a cross-sectional study

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Background: **Exploration of cardiometabolic alterations in the pre-adolescent stage is necessary to characterize possible patterns for matabolic syndrome (MetS) in the earliest stages of the life. However, defining specific cut-off points for metabolic and vascular markers represents a complex task in pre-adolescent populations. This study aimed to estimate the prevalence of MetS and its components in children aged 5-9 years old by using the MetS definition for adolescents with the lowest cut-off points, and evaluate its relationship with overweight and socio-demographic determinants.**

Methods: **A total of 494 children were evaluated. Multivariate models with filtered variables in preliminary univarite analyses were built to find predictive factors of MetS and its components.**

Results: **The prevalence of MetS was 8.7% in the studied children. Multivariate models showed that age, overweight and low socioeconomic stratum were associated with MetS; low high-density lipoprotein cholesterol was not significantly associated with any variable; high triglycerides were positively associated with age, overweight and inversely associated with kilocalories/day; female gender was the only variable significantly associated with high fasting glucose (inverse association); and age, gender and overweight were significant factors for increased waist circumference. In the case of high blood pressure, no variable was classified to the multivariate analysis.**

Conclusions: **This study showed disturbing figures regarding cardiometabolic risk in the children based on comparisons with studies in adolescents. Further studies are needed to confirm the utility of the de Ferranti Mets definition in children.**

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Key words: **fasting glucose; metabolic syndrome; obesity**

Introduction

Cardiometabolic diseases (CMD) as hypertension, type 2 diabetes, and cardiac and cerebrovascular disease are a group of disorders associated with environmental and genetic factors, and burden of these diseases has increased in developing countries in recent years.[1,2] The establishment of CMD in adults is the result of pathological chronic processes that can start in early life stages.[3] Currently, obesity, a well-known factor associated to CMD developing, is increasingly reported as a public health problem in children and adolescents.[4,5]

Metabolic syndrome (MetS), defined as the combination of abdominal obesity and alterations in glycemia, blood lipids and blood pressure, is a predictor of increased risk for CMD. There are several definitions and criteria for this syndrome in adults,[6-8] a few definitions for adolescents[9-11] but none for prepubertal children. However, the exploration of cardiometabolic alterations in the pre-adolescent stage is necessary to characterize possible patterns for this risk in the earliest stages of the life.

In Colombia, data regarding cardiometabolic risk in younger children are lacking, although there is some information about the problem of overweight. According to an analysis from the Colombian National Nutrition Survey (ENSIN) in 2005, there was a positive association between television viewing and overweight in children aged 5-12 years.[12] Moreover, the prevalence of overweight and obesity increased by 10% in Colombians in 2015 compared with that in 2005; and in some regions, the prevalence of overweight in children was similar to that reported from the United States.[13] Since defining specific cut-off points for metabolic and vascular markers represents a complex task in pre-adolescent populations, the aim of the present study was to use the MetS definition by de Ferranti et al[9] for

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adolescents with the lowest cut-off points, to estimate the prevalence of this condition and its components as well as its relationship with overweight and socio-demographic determinants in children between 5 and 9 years old.

Methods

This study inlcuded 494 children from both genders aged 5-9 years from a cross-sectional scholar population survey, the IFRECNTEC Study (identification of risk factors for adult non-communicable chronic disease in schooled population) in the city of Cali, Colombia.[14] Informed written consent was obtained from both the parent and child. The study was reviewed and approved by the Ethics Committee at University of Valle.

Fasting glucose, high-density lipoprotein cholesterol (HDL-C), and triglycerides were determined by using commercial kits (Biosystems Inc., Spain) in an automatic Biosystems analyzer (Biosystems Inc., Spain). Mercury sphygmomanometers with an appropriately sized cuff were used to measure blood pressure in a sitting position after 15 minutes of rest, and the mean of two readings was used for the analysis. Body weight and height were measured using standard techniques and instruments, and body mass index (BMI) was then calculated. Waist circumference (WC) was measured from the midpoint between the lateral iliac crest and the lowest rib using a flexible steel tape measure. Nutritional intake was assessed by using a 24-hour recall survey and dietary intake information was processed by using the CERES Software (Version 1.02, Food and Agriculture Organization of the United Nations, 1997).

Metabolic syndrome

MetS was estimated according to the criteria defined by de Ferranti et al:[9] WC >75th percentile (age and sex-specific), triglycerides ≥100 mg/dL (1.1 mmol/L), HDL-C <50 mg/dL (1.3 mmol/L) for ≤14 years old and <45 mg/dL (1.17 mmol/L) for ≥15 years old, and systolic blood pressure and/or diastolic blood pressure >90th percentile (age, height and sex-specific). High fasting glucose component was defined according to the International Diabetes Federation (IDF) guidelines: glucose ≥100 mg/dL (5.6 mmol/L). MetS was defined when three or more of the above-mentioned criteria were present in the subject.

Data analysis

Variables of the study were described as continuous variables or proportions. Continuous variables were presented as means and its standard deviation or mean and its interquartile range according to their distributions. Mann-Whitney *U* and Student *t* tests for continuous variables, and χ^2 test for proportions, were used to assess differences by absence/presence of MetS. Multiple logistic regression models were built to explain MetS and its components with variables of potential influence which were significant as predictors in a previous univariate analysis with *P* value <0.250. In the final multiple models, a *P* value <0.05 was considered significant. Variables evaluated in the logistic regression analyses were age, gender, socioeconomic stratum (low, middle, high), overweight and caloric intake. Overweight condition was defined according to BMI percentiles from the International Obesity Taskforce.[15] Because of the lack of percentile data for WC in the Colombian pre-pubertal population, increased WC component was evaluated using percentile data from the McCarthy et al study in the British population.[16] The reason for this choice was based on the similarity between the percentile curve patterns for WC in adolescence described by McCarthy et al study[16] and by a Colombian study.[17] The proximity between the

Table 1. Description of study population

Variables	Metabolic syndrome		
	No (*n*=451)	Yes (*n*=43)	*P* value
Age (y)	8.2 (7.3-9.2)	8.8 (8.0-9.3)	0.058
Gender, male/female	234/217	22/21	0.928
BMI (kg/mts^2)	15.6 (14.5-17.1)	19.5 (17.8-22.7)	**<0.001**
Waist circumference (cm)	55.0 (52.0-58.0)	62.5 (60.0-69.0)	**<0.001**
Systolic blood pressure (mmHg)	90.0 (85.0-100.0)	100.0 (95.0-107.5)	**<0.001**
Diastolic blood pressure (mmHg)	55 (50-60)	60 (55-70)	**0.001**
Triglycerides (mg/dL)	65 (49-87)	129 (106-178)	**<0.001**
Glucose (mg/dL)	84.6±8.9	87.2±10.6	0.069
HDL-C (mg/dL)	51.2±9.7	40.2±6.8	**<0.001**
Kilocalories/d	1905.4±639.1	1925.6±658.2	0.956
Socioecomic stratum			
Low, *n* (%)	259 (57.4)	23 (53.5)	
Middle, *n* (%)	80 (17.7)	5 (11.6)	
High, *n* (%)	112 (24.8)	15 (34.9)	0.305

Data are median (interquartile range) or mean±standard deviation. Significant associations are shown in bold. BMI: body mass index; WC: waist circumference; HDL-C: high-density lipoprotein cholesterol.

Table 2. Univariate analysis (non-adjusted OR and 95% CI) and multivariate analysis (final model) for components of metabolic syndrome by potential predictive factors and the final model (*n*=494)

Variables	*n*	Non-adjusted OR (95% CI)	Final model*OR (95% CI)	*P* value
Age				
<8 y	205	1.00 (reference)	1.00 (reference)	
≥8 y	289	**2.51 (1.20-5.22)**	**2.24 (1.04-4.85)**	**0.014, 0.039**
Gender				
Male	256	1.00 (reference)		
Female	238	1.02 (0.55-1.92)		0.928
Socioeconomic stratum				
Low	282	1.00 (reference)	1.00 (reference)	
Middle	85	0.70 (0.25-1.91)	**0.28 (0.09-0.86)**	0.491, **0.026**
High	127	1.50 (0.75-2.99)	0.69 (0.31-1.53)	0.241, 0.367
Overweight/obesity				
No	405	1.00 (reference)	1.00 (reference)	
Yes	89	**8.59 (4.41-16.70)**	**10.65 (5.09-22.20)**	**<0.001, <0.001**
Kilocalories/d				
<75th percentile	371	1.00 (reference)		
≥75th percentile	123	0.66 (0.30-1.48)		0.321

Significant associations are shown in bold. OR: odds ratio; CI: confidence interval. *: composed by variables from univariate (non-adjusted) analysis with *P*<0.250.

percentile curves is described in a comparison of centile values for WC in different populations by Avalos et al.[18] The National Heart, Lung and Blood institute percentile data were used to assess high blood pressure component. Statistics were computed using STATA 8.0.

Results

Description of study variables by absence or presence of MetS is shown in Table 1. As expected, BMI and cardiometatabolic risk markers were significantly higher (with exception of age and glucose levels, $P>0.05$) and HDL-C was significantly lower in children with MetS. There were no significant differences in gender, socioeconomic stratum and caloric intake by absence or presence of MetS.

The prevalence of MetS was 8.7%. Low HDL-C was found in 47.6 % of the children, increased WC in 33%, and high triglycerides in 20.4%; the prevalence of high fasting glucose and blood pressure were the lowest, 4.0% and 2.6%, respectively.

The number of children below and above 8 years was comparable, as well as the number of individuals by gender. Most of the children belonged to the lowest socioeconomic stratum. Eighty-nine (18%) children had overweight or obesity. In this subgroup, increased WC (92.1%) and low HDL-C (55%) were the most prevalent MetS components, and 25 (28%) had MetS. In the overweight/obese group, the prevalence for high triglycerides, fasting glucose and blood pressure were 38.2%, 5.6% and 3.0%, respectively.

In the univariate analysis to filter potential associated factors for MetS, age and overweight were significantly associated, and socioeconomic stratum was qualified for the multivariate analysis (Table 2). In the final multivariate model, age and overweight remained significant and middle socioeconomic stratum became inversely and significantly associated with MetS in comparison with the low stratum (Table 2).

Table 3. Non-adjusted odds ratios (95% confidence interval) for components of metabolic syndrome by potential predictive factors

Variables	Low HDL-C	High triglycerides	High fasting glucose	High blood pressure	Increased WC	*P* value
Age						
<8 y	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥8 y	0.77 (0.54-1.11)	**1.89 (1.18-3.04)**	2.18 (0.78-6.12)	0.82 (0.27-2.48)	**1.62 (1.10-2.40)**	0.172, **0.008**, 0.135, 0.730, **0.014**
Gender						
Male	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
Female	1.13 (0.79-1.61)	1.30 (0.84-2.02)	**0.23 (0.08-0.77)**	1.26 (0.41-3.81)	**0.62 (0.43-0.91)**	0.495, 0.234, **0.016,** 0.679, **0.017**
Socioeconomic stratum						
Low	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
Middle	1.29 (0.79-2.10)	0.89 (0.48-1.65)	0.46 (0.10-2.07)	0.65 (0.14-3.05)	**2.40 (1.44-3.98)**	0.295, 0.725, 0.313, 0.590, **<0.001**
High	1.00 (0.65-1.52)	1.04 (0.62-1.74)	0.62 (0.20-1.93)	0.21 (0.02-1.70)	**2.19 (1.41-3.42)**	0.234, 0.873, 0.412, 0.146, **<0.001**
Overweight						
No	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
Yes	1.41 (0.91-2.19)	**2.79 (1.71-4.54)**	1.70 (0.64-4.56)	1.17 (0.31-4.34)	**63.0 (28.0-141.8)**	0.121, **<0.001,** 0.285, 0.812, **<0.001**
Kilocalories/d						
<75th percentile	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥75th percentile	0.89 (0.59-1.34)	0.64 (0.37-1.11)	1.00 (0.35-2.82)	0.54 (0.11-2.47)	1.49 (0.97-2.14)	0.601, 0.115, 0.991, 0.428, 0.063

Significant associations are shown in bold. HDL-C: high-density lipoprotein cholesterol; WC: waist circumference.

Table 4. Multivariate models* odds ratios (95% confidence interval) for components of metabolic syndrome by potential predictive factors

Variables	Low HDL-C	High triglycerides	High fasting glucose	Increased WC	*P* value
Age					
<8 y	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥8 y	0.75 (0.52-1.08)	**1.82 (1.12-2.94)**	2.27 (0.80-6.39)	1.49 (0.89-2.49)	0.135, **0.015**, 0.120, 0.127
Gender					
Male		1.00 (reference)	1.00 (reference)	1.00 (reference)	
Female		1.29 (0.81-2.03)	**0.25 (0.08-0.76)**	**0.55 (0.33-0.92)**	0.269, **0.015**, **0.024**
Socioeconomic stratum					
Low	1.00 (reference)			1.00 (reference)	
Middle	1.20 (0.72-1.98)			1.21 (0.54-2.27)	0.470, 0.759
High	0.94 (0.60-1.45)			0.93 (0.48-1.78)	0.784, 0.835
Overweight					
No	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
Yes	1.44 (0.90-2.28)	**2.86 (1.73-4.73)**		**63.10 (27.40-145.60)**	0.120, **<0.001**, **<0.001**
Kilocalories/d					
<75th percentile	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	
≥75th percentile		**0.56 (0.31-0.99)**		1.13 (0.61-2.07)	**0.046**, 0.691

Significant associations are shown in bold. HDL-C: high-density lipoprotein cholesterol; WC: waist circumference. *: composed by variables from univariate (non-adjusted) analysis with $P<0.250$. Each column represents an adjusted model. For high blood pressure component none variable was found with $P<0.250$ in the univariate analysis.

Table 5. Selected studies with evaluation of metabolic syndrome in pre-pubertal children

References	Country	Kind of population	*n*	Age range (y)	Most prevalent component	MetS prevalence (used definition)	Associated factors
Golley et al, 2006[19]	Australia	Overweight children	99	6-9	High WC (17%)-EGIR criteria Low HDL-C (12%)-NCEP criteria High systolic blood pressure (41%)-NCEP modified, EGIR modified and Lambert modified	4% (EGIR) 0% (NCEP) 59% (Lambert) 39% (EGIR modified) 3% (NCEP modified)	Non-evaluated
Casazza et al, 2009[20]	US	Hispanic, African American and white children	202	7-12	High fasting glucose (37%)	8.4% (revised Cook et al[10])	Hispanic ethnicity, carbohydrate intake
Brufani et al, 2011[21]	Italy	Overweight/obese	201	Non-provided (mean age for two groups with MetS and without MetS: 9.4±1.1 and 9.3±1.7, respectively)	Non-provided	11.9% (NCEP ATP-III modified)	Central obesity index and insulin sensitivity index
Pedrosa et al, 2010[22]	Portugal	Overweight/obese schoolchildren	82	7-9	High blood pressure (62.6%)	15.8% (Cook et al[10])	High leptin concentrations and acanthosis
Atabek et al, 2006[23]	Turkey	Obese	100	7-11	High triglycerides (29%)	20% (WHO criteria adapted for children)	Non-evaluated
Agirbasli et al, 2009[24]	Turkey	Schoolchildren	180	8-12	High blood pressure, in boys 26%, in girls 30%	1.1% (an adapted NCEP definition) Boys 0% and girls 2.3% (adapted WHO definition) Boys 3.3% and girls 3.4% (adapted IDF definition)	Levels of sex hormone-binding globulin
D'Adamo et al, 2010[25]	Italy	Obese	89	6-10	High blood pressure (34.8%)	13.5% (adapted criteria with BMI Z score >2 instead of WC component)	Non-evaluated
Strufaldi et al[26]	Brazil	Schoolchildren	929	6-10	Low HDL-C (25.4%), additionally total cholesterol (30.7%)	9.3% (NCEP ATP-III modified) 1.9% (WHO)	Overweight
Holst-Schumacher et al, 2009[27]	Costa Rica	Overweight/obese schoolchildren	214	8-10	Low HDL-C (54.7%)	5.6% (Tapia & Ceballos proposed definition)	Age
Agudelo Ochoa & Arias-Arteaga, 2008[28]	Colombia	schoolchildren	2620	6-9	Low HDL-C (29.8%)	5.1% (adapted criteria with BMI ≥95th percentile instead of WC component)	Low socioeconomic status
Present study	Colombia	schoolchildren	494	5-9	Low HDL-C	de Ferranti et al[9] criteria for adolescents de Ferranti et al[9] criteria with WC as central criterion	Overweight and age

MetS: metabolic syndrome; EGIR: European Group for the Study of Insulin Resistance; NCEP: National Cholesterol Education Program; WHO: World Health Organization; IDF: International Diabetes Federation; WC: waist circumference; HDL-C: high-density lipoprotein cholesterol; BMI: body mass index; ATP: adult treatment panel.

The univariate analysis to find potential associated factors for each component of metabolic syndrome is shown in Table 3. Subsequent multivariate models with filtered variables (Table 4) showed that low HDL-C was not significantly associated with any variable; high triglycerides were positively associated with age, overweight and unexpectedly inversely associated with kilocalories/day; gender (female) was the only variable significantly associated with high fasting glucose (inverse association); and age, gender and overweight were significant factors for increased WC. In the case of high blood pressure, no variable was qualified for the multivariate analysis.

Discussion

The present study evaluated the prevalence of MetS and its components in children aged 5-9 years old by using the de Ferranti et al[9] criteria for adolescents. We found that low HDL-C was the most prevalent component. In addition, overweight, gender and age were associated with specific MetS components in non-adjusted and adjusted models and socioeconomic stratum was a significantly and inversely associated with MetS after adjustments.

Table 5 shows some recent studies which evaluated MetS in pre-pubertal children. The prevalence in the children of our study was similar to that reported by Cassazza et al[20] and Strufaldi et al,[26] but higher than that found in the studies by Agirbasli et al,[24] and Agudelo-Ochoa and Arias-Artega[28] conducted in scholar populations. Moreover, the prevalence of MetS in the present study was even higher than that reported in some studies conducted exclusively in overweight and obese children such as Golley et al[19] and Holst-Schumacher et al.[27] Taking into account only the

overweight children of our study, the prevalence of MetS (28%) was much higher than that described in the other overweight populations-specific studies from Table 3, with exception of the Golley et al study when Lambert and European Group for the Study of Insulin Resistance definitions were applied.[19]

Regarding prevalence of components, our study is consistent with the findings of studies which examined Latin-American pre-pubertal populations with low HDL-C as the most prevalent criterion. Likewise, this component was the most prevalent in the Golley et al study from Australia when National Cholesterol Education Program cut-off point was applied.[19] Similarly, among the European literature, three studies had similar high blood pressure as the most prevalent MetS component,[22,24,25] one reported high triglycerides as the most prevalent,[23] and one did not have this information available[21] (Table 3). In the study by Casazza et al of children from the United States, the most prevalent abnormality was high fasting glucose,[20] however, it was the least prevalent in the rest of studies, which suggesting a specific pattern of alterations by world regions. Moreover, in the overweight children of the present study, only five cases had high fasting glucose (HFG), which is in line with the findings by Grandone et al[29] and Costa et al,[30] where low prevalence of HFG was reported in Italian and Brazilian obese adolescents, respectively. In fact, Costa et al[30] found that the use of homeostatic model assessment insulin resistance in place of glucose identified more numbers of participants with MetS. The component of HFG could be a late alteration in the course of MetS in pediatric population with overweight. However, further research is required to confirm this assumption and explain the differences of MetS components in the studies mentioned above.

In comparison with studies in adolescent stage, the children of our study had a prevalence of MetS (8.7%) which was comparable to that reported by de Ferranti et al (9.2%),[9] and higher than that found in other studies of United States adolescents which used pediatric MetS definitions of Cook et al (4.2%)[10] and IDF criteria (4.5%).[31] However, a study of Mexican adolescents with a MetS definition similar to de Ferranti et al criteria (except for blood pressure cut-off point, ≥90th percentile) reported a higher MetS prevalence of 20%.[32] Interestingly, a study by Mehairi et al[33] in adolescents (12-18 years old) from United Arab Emirates reported a high prevalence of 13% for MetS, considering that definition used was the IDF criteria, which has higher cut-off points for MetS components (mainly blood pressure) and requests increased WC as central criterion. Regarding the prevalence of MetS components in the mentioned adolescent populations, low-HDL was described as the most prevalent abnormality in the de Ferranti et al[9] and Halley Castillo et al[32] and Mehairi et al[33] studies, and the second most prevalent in the Cook et al and Ford et al studies after high triglycerides and abdominal obesity, respectively.

Several independent associations with overweight and socio-demographic variables were observed. The associations of overweight with variables such as high triglycerides, increased WC and MetS, were expected findings according to similar investigations that have described these relationships.[34,35] The relationship between age and triglycerides is in agreement with studies that showed positive non-adjusted correlates and the finding of age as an independent determinant of high triglycerides in diabetic children.[36,37] In respect to differences by gender, our findings of association between HFG and male gender are in agreement with the Agudelo-Ochoa and Arias-Arteaga study[28] and with a previous evaluation of MetS in adolescents,[38] both of them in Colombian populations. However, in these studies, the relationship was non-adjusted. In addition, Holst-Schumacher et al[27] did not find differences by gender regarding HFG, but a higher proportion of girls were found with low HDL-C.

Another relevant finding was the association between a higher socioeconomic stratum and a lower opportunity of having MetS. Low incomes and social inequalities have been associated with the burden of CMD.[39] Some specific works regarding MetS have reported higher opportunity for this syndrome, mainly in female populations with low income, low education level and unfavorable social class (established by occupation).[40,41] However, both positive and inverse relationships with socioeconomic variables have been described. For instance, Lawlor et al[42] found that family income and parental education were inversely associated with insulin resistance in Danish children but were positively associated with insulin resistance in Estonian and Portuguese children. Most of the children in our study belonged to the lowest socioeconomic stratum, and could be influenced by environmental factors not related to hypercaloric diets, since caloric intake was not a significant determinant of MetS.

It is important to consider the fact that prevalence of MetS varies according to the definitions used by researchers, as it has been demonstrated in several studies conducted in adolescents.[38,43] Since there are no definitions for children below 10 years old to evaluate that variation, a prospective approach could be based on percentile distributions of cardiometabolic risk factors. A very recent study in children aged 6-14 year from Southern Italy by Martino et al[44] has explored MetS (prevalence of 4.2%) based on cut-off points derived from a preliminary analysis of percentile distribution of each MetS component in that population. However, the authors reported difficulties to compare their prevalence with those from others studies, since age ranges differed, being in general much larger and rightward displaced (10-

18 years). They found disparities in MetS prevalence in the study by Mehairi et al[33] in Emirati adolescents (much higher in this latter, 13%) as well as similarities with one study in Indo-Iranian adolescents (10-18 years old) with normal BMI.[45] Both studies used the IDF definition.[33,45] Therefore, further studies based on percentile distribution of MetS components are required. The rationale for using the de Ferranti et al[9] criteria for adolescents in our study with preadolescent children was based on assuming lower levels of cardiometabolic risk markers in children below 10 years, and the cut-off points from the de Ferranti et al[9] criteria are the lowest in comparison with others definitions for adolescents. Given that the prevalence of MetS in our children was comparable with the prevalence of MetS in adolescents using the same definition, this could mean that cardiometabolic risk could be present in younger children as much as in the adolescents, and this pattern could be similar or different depending on world regions. Clearly, future studies need to concentrate not only on geographic distributions but also on ethnicity and on related dietary habits differences along with the complex interaction with sexual maturity.

Since caloric intake was not consistently associated with other components and metabolic syndrome, the unexpected inverse association between caloric intake and high triglycerides in the multivariate analysis may be a result by chance. On the other hand, it is also possible be due to the influence of some confounder no evaluated in this study.

The present study was limited by the lack of data regarding pubertal changes, ethnicity, physical activity and family history of CMD, which could have allowed more robust adjustments. Because of the cross-sectional design, the present study does not establish evident cause-effect relationships. The strengths of our study concern a possible first evaluation of the de Ferranti et al's criteria.[9] MetS definition in a population of children below 10 years and the use of a multivariate analysis to verify independence in the evaluated associations.

In conclusion, the results of our study show disturbing figures regarding cardiometabolic risk in the children based on comparisons with studies in adolescents. Specific monitoring in the pre-adolescent stage should be conducted since clinical manifestations and cardiometabolic risk in puberty could be present years before puberty. Further and more detailed studies are needed in the younger school children in order to assess the utility of the de Ferranti et al[9] definition in this pediatric population.

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