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Cardiovascular risk factors, their associations and presence of metabolic syndrome in adolescents

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Abstract

Objective: To evaluate the occurrence of metabolic syndrome (MS) and independent associated risk factors in adolescents in the city of Vitória, Brazil.

Methods: We assessed 380 adolescents aged 10 to 14 years attending public schools. Body mass index and blood pressure at rest were measured. Fasting plasma concentrations of total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides and glucose were also obtained.

Results: The prevalence of overweight was 9.6% for boys and 7.4% for girls, while obesity was found in 6.2 and 4.9%, respectively. Triglyceride concentrations were borderline or high in 6.8 and 3.4% of the boys and in 11.8 and 5.9% of the girls. HDL-cholesterol was below recommended levels in 8.5% of the boys and in 9.9% of the girls. Blood pressure at rest was borderline for 5.1% of the boys and 7.9% of the girls, while 3.4% of both boys and girls were hypertensive. Fasting glycemia was high in 0.6% of the boys and in 0.5% of the girls. In the group studied, 2.8% of the boys and 2.5% of the girls had two risk factors associated with MS. Prevalence of MS was 1.1% for boys and 1.5% for girls, and overall prevalence was 1.3%.

Conclusions: MS and associated cardiovascular risk factors are serious clinical conditions in this age group. A significant number of adolescents showed borderline results, which may increase the prevalence of MS or independent risk factors in the short term. More investments should be made in primary prevention, considering that early diagnosis is an issue of fundamental importance.

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Introduction

Metabolic syndrome (MS) is defined as the co-occurrence of several risk factors for cardiovascular disease, such as hyperinsulinemia, dyslipidemia, hypertension, carbohydrate metabolism disorders and abdominal obesity[1]; all these factors are significantly associated with higher mortality.

Although MS has been conceptually well defined, the lack of a global consensus to diagnose it results in markedly different prevalence rates in distinct studies.[2] Adult criteria have been adapted and are currently used as pediatric reference values to determine MS prevalence in children and adolescents.[3,4] Such variety of criteria for the identification of MS suggests that, although the determination of prevalence is important, it is also necessary to identify isolated cardiovascular risk factors in children and adolescents, because of the potential risk that they represent.

The presence and clustering of risk factors are well documented; however, symptoms of cardiovascular diseases

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are rare in children, and therefore such factors are often overlooked.[5] There is a clear association between atherosclerotic cardiovascular disease and hypercholesterolemia, and the knowledge that childhood levels may be predictive of disease occurrence in adults indicates that primary preventive measures should be adopted. One way to evaluate the risk of atherosclerotic cardiovascular disease is the measurement of serum total cholesterol (TC), lipoprotein fractions (LDL-cholesterol and HDL-cholesterol) and triglycerides.[6]

Although some international studies have focused on MS,[5,7] few studies in Brazil[8] have provided specific population data about children and adolescents or about the early identification of isolated or clustered risk factors during this important period of life, when the progression of atheromatous disease potentially accelerates.[7] Therefore, the aim of this study was to determine the presence and association of cardiovascular risk factors as predictors for MS in Brazilian adolescents.

Methods

This cross-sectional study was conducted from March 2003 to August 2005 to examine adolescents of both sexes aged 10 to 14 years in the city of Vitória. The study protocol was approved by the Research Ethics Committee of Faculdade Salesiana de Vitória, Brazil.

Vitória is the capital city of the state of Espírito Santo, Brazil, and all of its population is urban. According to official data,[9] 27,491 adolescents in the age group focused in the present study live in the city, with 16,416 (59.71%) of them attending public schools. To calculate the minimum sample size for the present study, a general equation for sample size in both large and small populations[10] was used at a confidence level of 95% and a confidence interval of 5%; the value assigned to p was the one that would result in the largest sample size. As a result, we obtained n = 380. Random sampling took into consideration the proportion of the population in this age group in the seven administrative areas of the city. A total of 177 boys and 203 girls, all students, were selected by drawing names. After the parents received explanations about the methods and the importance of the study, the adolescents were invited, through their parents or guardians, to participate in the study; those who accepted to participate signed an informed consent term. Sexual maturity was assessed by the occurrence of menarche in girls and by the presence of axillary hair in boys.[11] The socioeconomic status of the study population was classified as class A (highest) to E (lowest) according to a questionnaire applied by the MONICA-WHO Project in Vitória.[12] None of the students reported smoking habit, any previously diagnosed metabolic disease or use of oral contraceptives (exclusion criteria). Adolescents who refused to undergo laboratory tests were replaced by other names previously drawn, until the predetermined sample size was achieved.

The adolescents' chronological ages were expressed in hundredths of a year using the date of data collection and the date of birth as references. Body mass and height were measured and used to calculate body mass index (BMI = kg x m^2). Overweight and obesity were defined using BMI values for age and sex: the cutoff point was ≥ 85th; overweight was defined as BMI < 95th percentile and obesity as BMI ≥ 95th percentile.[13]

Blood pressure was measured three times at resting intervals of about 2 minutes according to the method established in the IV Brazilian Guidelines for Hypertension,[14] using a mercury sphygmomanometer with appropriate arm cuff length; the average of these three determinations was used to express the individual's systolic and diastolic blood pressures. The blood pressure values at the 90th and 95th percentiles for children and adolescents were used as the classification criterion, according to height percentiles for both sexes. Values < 90th percentile were classified as normal blood pressure; between the 90th and 95th percentile, as borderline; and ≥ 95th percentile, as hypertension.[13,14]

Fasting serum glucose, triglycerides, TC, LDL-cholesterol and HDL-cholesterol were determined using conventional laboratory enzymatic and colorimetric techniques. Lipid prevalence was calculated using the reference values suggested for the 2 to 19-year-old Brazilian population in the I Atherosclerosis Prevention Guidelines in Childhood and Adolescence.[15]

As there is no established cutoff point for the diagnosis of MS,[16,17] we adopted the values suggested and adjusted for this age group in another study.[18] MS was thus defined as the occurrence of three or more of the following criteria[8]: obesity (BMI) ≥ 95th percentile for sex and age; triglycerides ≥ 130 mg/dL; HDL-cholesterol < 35 mg/dL; blood pressure ≥ 95th percentile for sex, age and height; fasting glycemia ≥ 110 mg/dL.

Descriptive statistics was used for data analysis by sex and age (means, standard deviations, 95% confidence intervals and percent frequency). The Student *t* test for independent samples was used for the comparison of means, as appropriate. The level of significance was set at $p < 0.05$.

Results

Mean age was 12.65±1.48 years for boys and 12.45±1.41 for girls. Among the 177 boys and 203 girls included in this study, 38.4 and 45.8%, respectively, were sexually mature ($p < 0.05$). The socioeconomic classification revealed that 14.7% of the boys and 15.8% of the girls belonged to class B; 61 and 52% to class C; 23.2 and 31.5% to class D; and 1.1 and 0.5% to class E.

Table 1 shows means and 95% confidence intervals (95%CI) found in the biochemical analysis. Only HDL-cholesterol in 10-year-old boys ($p = 0.03$) was significantly higher than in girls. All the other biochemical variables

Table 1 - Biochemical profile of students according to age and sex (mean and 95%CI)

Age (years)/Sex	TC (mg/dL)	HDL-C (mg/dL)	LDL-C (mg/dL)	Triglycerides (mg/dL)	Glycemia (mg/dL)
10					
Male	163 (151-175)	50* (47-53)	98 (88-108)	74 (63-85)	83 (80-86)
Female	155 (147-163)	45 (43-47)	95 (89-101)	72 (63-81)	81 (79-83)
11					
Male	148 (140-156)	44 (40-48)	89 (82-170)	74 (59-89)	79 (77-81)
Female	162 (150-174)	43 (40-46)	102 (91-113)	80 (71-89)	81 (79-83)
12					
Male	142 (136-148)	44 (41-47)	84 (78-90)	68 (61-75)	86 (83-89)
Female	146 (139-153)	46 (43-49)	86 (80-92)	74 (66-82)	84 (82-86)
13					
Male	160 (152-168)	48 (45-51)	98 (91-105)	70 (60-80)	83 (81-85)
Female	145 (138-152)	44 (42-46)	84 (77-91)	84 (74-94)	82 (80-84)
14					
Male	144 (137-151)	42 (39-45)	88 (82-94)	67 (59-75)	83 (81-85)
Female	147 (139-155)	45 (42-48)	87 (80-94)	76 (69-83)	79 (76-82)
Male mean	151 (147-155)	45 (42-48)	91 (83-99)	70 (60-80)	83 (81-85)
Female mean	152 (148-156)	45 (44-46)	91 (87-95)	77 (73-81)	81 (80-82)
Overall mean	151 (148-154)	45 (44-46)	91 (88-94)	74 (71-77)	82 (81-83)

95%CI = 95% confidence interval; HDL-C = high-density lipoprotein cholesterol; LDL-C = low-density lipoprotein cholesterol; TC = total cholesterol. Student *t* test for independent samples.
* Difference between boys and girls: $p < 0.05$.

showed no differences when the means by age group were compared between sexes.

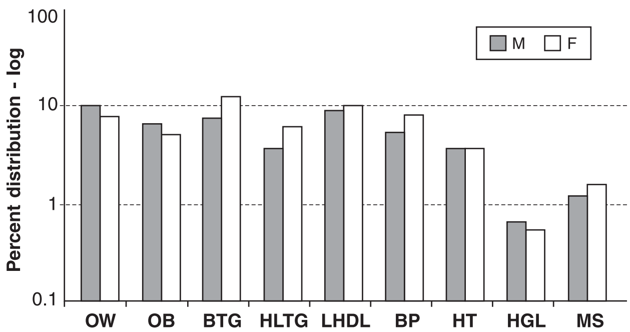
The prevalence of borderline or high cholesterol values in boys and girls was 44.06 and 45.33%, respectively (mean = 44.70%). LDL-cholesterol was borderline or high in 23.73% of the boys and in 28.08% of the girls (mean = 25.91%), and triglycerides, in 10.18 and 17.72%, respectively (mean = 13.95%). HDL-cholesterol was below desirable values in 56.50% of the boys and in 47.48% of the girls (mean = 52.14%).

Figure 1 shows the percent distribution of factors associated with MS for both sexes. According to the cutoff points, the prevalence of overweight was 9.6% for boys and 7.4% for girls (mean = 8.4%), and of obesity, 6.2% for boys and 4.9% for girls (mean = 5.5%). Triglycerides were borderline or high in 6.78 and 3.40% of the boys and in 11.82 and 5.90% of the girls, respectively. HDL-cholesterol was below desirable levels in 8.5% of the boys and in 9.9% of the girls. Blood pressure was borderline in 5.1% of the boys and in 7.9% of the girls (mean = 6.6%) and 3.4% of both boys and girls were hypertensive. Fasting glycemia was high in 0.6% of the boys and in 0.5% of the girls (mean = 0.55%). In the group studied, 2.82% of the boys and 2.46% of the girls (mean = 2.64%) had two factors associated with MS; MS prevalence according to the criteria used in this study was 1.13% for boys and 1.48% for girls, with an overall prevalence of 1.32%.

Discussion

The detection of risk cardiovascular factors in children is fundamental for the prevention of MS and future complications. This study evaluated a group of individuals that represented 59.71% of all the population in this age group; it may, therefore, be considered a representative sample of the universe of adolescents (although only public school students were assessed in the present study). In this age, due to gonadal hormone influence, sexual maturation can be an important confusion factor. However, since the molecular mechanisms involved in sexual maturation are not well understood, they were not part of the objective of our study.

Mean cholesterol was 151±28 mg/dL, and 44.70% of the participants had borderline or high levels. Atheromatosis is



BP = borderline pressure; BTG = borderline triglycerides; HLTG = high triglycerides; LHDL = low HDL-cholesterol; HGL = hyperglycemia; HT = hypertension; MS = metabolic syndrome; OB = obesity; OW = overwheight.

Figure 1 - Percent distribution of components according to the cut-off point established for metabolic syndrome in both sexes and their prevalence

found in the intimal layer of the aorta in children when cholesterol levels are between 140 and 170 mg%; therefore, the epidemiological level for plasma cholesterol in children should be set at 150 mg%.[19] Mean LDL-cholesterol was 91±25 mg/dL in this study, and was high in an important number of adolescents (25.91%). The levels of HDL-cholesterol were lower in our children (45±9 mg/dL) when compared with values reported in other studies,[20, 21] which is explained by the fact that our sample had lower TC levels. Moreover, mean percentage of the HDL-cholesterol fraction to TC was 30%, which is within normal values (20 to 30%).[20]

Blood triglycerides are associated with accumulation of low-density lipoproteins and therefore with the risk of developing atheromatous disease. High triglyceride levels are a key component in MS. In our study, adolescents had a mean triglyceride level of 74±31 mg/dL, which is higher than that found in the Bogalusa Heart Study, which examined 3,446 children aged 4 to 14 years.[22]

The prevalence of adolescents with hyperglycemia in this study was 0.6% among boys and 0.5% among girls. This metabolic variable deserves attention because its incidence has increased surprisingly, probably due to the increased incidence of obesity among adolescents in the recent years.[23]

Hypertension manifests as an increase in blood pressure above an arbitrarily established value and is an independent risk factor at any age. The problem is more complex in children because of growth and development,[24] as it is known that blood pressure increases during growth and maturation. Blood pressure in our study was measure three times, but at only one occasion; the prevalence of undesirable systolic or diastolic pressure levels was lower in our sample (6.6% between the 90th and 95th percentiles, and 3.4% above the 95th percentile) than the 9.7 and 6.5% found by the Task Force,[25] and the 8.3 and 9.8% reported by Oliveira et al.,[26] which also measured blood pressure at one single occasion.

Obesity, a chronic multifactorial disease in which genetic and environmental factors are associated,[27] has become an important pediatric problem in the last decades. In our sample, the prevalence of overweight was 8.4%, and obesity, 5.5%. In other countries, obesity is the most common health problem in childhood, and is associated with hypertension, diabetes mellitus and dyslipidemia[28] in adults. Moreover, it is the most common cause of resistance to insulin in childhood.[29] Data collected by the National Health and Nutrition Examination Survey showed a prevalence of overweigh and obesity (≥ 85th percentile) of 30%, and of obesity (only ≥ 95th percentile) of 15% in individuals aged 6 to 19 years.[30]

Still the focus of controversy,[31] MS draws attention because of its unfavorable effect on cardiovascular mortality, and studies show that its onset may occur in very early phases of life. Overweight and obesity seem to play an important role in MS.[32] Studies showed that obesity is usually associated with resistance to insulin and compensatory hyperinsulinemia, which may be the initial factor in the development of MS.[4]

No consensus has been reached about the diagnosis of MS in children and adolescents, and its prevalence is directly dependent on the diagnostic criteria used. Recent studies using different definitions and criteria and focusing on populations aged 5 to 19 years indicated a prevalence ranging from 3.6 to 4.8%.[5] In our children from Vitória, Brazil, the overall prevalence of MS was 1.32%, lower than the rates reported in other studies. Few studies with representative samples have been conducted in Brazil, but a recent study with 10 to 19-year-old Brazilian adolescents using a cutoff point established in the study revealed a prevalence of 6%.[33] However, that sample was very small, and the inclusion criterion was family history of type 2 diabetes, which somehow directed sample choice and may have affected the overall prevalence rate. Our study adds important data about risk factors to the diagnosis of MS. Moreover, it represents population distribution more reliably because the sample was randomly selected.

In summary, in this sample, the prevalence of MS and associated risk factors was generally lower than those found in the literature, maybe because our population came from less privileged socioeconomic classes (predominantly classes C and D), which, in Brazil, may indicate a greater difficulty in accessing agents that trigger risk factors. Evidence indicates that socioeconomic status may have an important effect on the prevalence of markers of cardiovascular risk.[34] However, MS is a serious clinical condition, and the lack of a global consensus may have under or overestimated its prevalence. It is important to note that, when the association of two risk factors for MS was evaluated, our prevalence increased to 2.64%. Moreover, if the reason to diagnose MS is to identify people at risk for developing cardiovascular disease, it seems wise to treat individuals with any abnormality, aiming at avoiding future diagnosis of MS.

This study also draws attention to the substantial number of adolescents presenting different types of risk factors, i.e., risk factors that are currently used for the diagnosis of MS and also risk factors currently classified as borderline which may in the future point to some direction. Studies have shown[3] that, among individuals classified as overweight (therefore not included in current prevalence rates), 6.8% have MS. For that reason, the considerably high prevalence of overweight adolescents may increase the rates of MS and the consequent cardiovascular mortality. This study contributes to the identification of MS risk factors in a group that did not have previously known risk factors (i.e., obesity, hypertension, dyslipidemia).

Finally, our data call attention to the severity of this problem and the need to provide attention to individuals in this age group, so as to prevent the development of isolated or associated risk factors of cardiovascular disease. When early diagnosis is achieved, causes and factors may be corrected, thus contributing to the reduction of future cases of cardiovascular disease.

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