Prevalence of metabolic syndrome in overweight and obese outpatient children and adolescents: comparative analysis using different clinical definitions

Prevalência de síndrome metabólica em amostra ambulatorial de crianças e adolescentes com sobrepeso e obesidade: análise comparativa de diferentes definições clínicas

Prevalencia de síndrome metabólica en muestra ambulatorial de niños y adolescentes con sobrepeso y obesidad: análisis comparativa de distintas definiciones clínicas

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ABSTRACT

Objective: To describe the prevalence of metabolic syndrome among children and adolescents with overweight and obesity according to standards proposed by literature.

Methods: Cross-sectional study comprising a total of 74 children and adolescents aged six to 17 years old and recruited for an interventional study. Anthropometric data (weight, height, body mass index and waist circumference), laboratorial data (lipid profile and fasting glycemia) and blood pressure were obtained. The prevalence of metabolic syndrome was determined by four criteria usually adopted, as observed in a systematic review (MS1 to MS4). Differences between the proportions of children diagnosed with metabolic syndrome according to the different classifications were studied, being significant $p<0.05$.

Results: The prevalence of metabolic syndrome ranged between 55.6% (95%CI 43.4-67.1%) and 74.0% (95% CI 62.2-83.2%), according to the chosen clinical definitions, being higher when more sensitive cut-off points were applied. Body mass index adoption as an anthropometric criterion did not interfere on metabolic syndrome diagnosis, and the observed prevalence was high (52.7%), regardless of the clinical definition. Abdominal obesity and hipertriglyceridemia were the most common observed abnormalities, and hyperglycemia had the lower prevalence.

Conclusions: The metabolic changes were prevalent in the studied population and overweight seems to be the determinant condition, highlighting the importance of early diagnosis and monitoring aiming to reduce cardiovascular diseases in early adult life.

Key-words: metabolic syndrome X; diagnostic; obesity; overweight; child; adolescent.

RESUMO

Objetivo: Descrever a prevalência de síndrome metabólica em amostra ambulatorial de crianças e adolescentes com sobrepeso e obesidade segundo critérios propostos pela literatura para sua definição.

Métodos: Estudo descritivo observacional transversal com 74 crianças e adolescentes, entre seis e 17 anos, selecionados para participarem de um estudo de intervenção, no qual foram coletados dados antropométricos (peso, estatura, índice de massa corporal e circunferência da cintura), laboratoriais (perfil lipídico e glicemia), além de pressão arterial. A prevalência de síndrome metabólica foi

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Conflito de interesse: nada a declarar

Recebido em: 30/4/2010
Aprovado em: 8/12/2010

determinada pelas quatro propostas mais frequentemente adotadas em uma revisão sistemática sobre o tema (SM1 a SM4), sendo obtidas as diferenças de proporções, com nível de significância de 0,05.

Resultados: A prevalência de síndrome metabólica variou de 55,6% (IC95% 43,4-67,1%) a 74,0% (IC95% 62,2-83,2%) de acordo com as propostas escolhidas, sendo mais elevada quando os pontos de corte eram mais sensíveis. O uso do índice de massa corporal como critério antropométrico não comprometeu, de forma significativa, o diagnóstico de síndrome metabólica. Apesar da variação, a prevalência encontrada foi elevada, atingindo, simultaneamente, por todas as propostas, 52,7% da amostra. As anormalidades mais observadas foram obesidade abdominal e hipertrigliceridemia e, a menos observada, foi a hiperglicemia.

Conclusões: As alterações metabólicas investigadas foram prevalentes em toda a amostra e o excesso de peso parece ter sido fator determinante no quadro descrito. Esse fato denota a importância do diagnóstico precoce e do monitoramento dessa população com o intuito de reduzir o risco de desenvolvimento de comorbidades cardiovasculares na vida adulta jovem.

Palavras-chave: síndrome X metabólica; diagnóstico; obesidade; sobrepeso; criança; adolescente.

RESUMEN

Objetivo: Describir la prevalencia del Síndrome Metabólica en muestra ambulatorial de niños y adolescentes con sobrepeso y obesidad según criterios propuestos por la literatura para su definición.

Métodos: Estudio descriptivo observacional transversal con 74 niños y adolescentes, entre 6-17 años, seleccionados para participar de un estudio de intervención, donde se recogieron datos antropométricos (peso, estatura, IMC, circunferencia de la cintura), laboratoriales (perfil lipídico y glucemia), además de presión arterial. La prevalencia del Síndrome Metabólica (SM) fue determinada mediante cuatro propuestas más frecuentemente adoptadas en una revisión sistemática sobre el tema (SM1 a SM4), siendo obtenidas las diferencias de proporciones, con nivel de significancia de 0,05.

Resultados: La prevalencia de SM varió de 55,6% (95% IC 43,4-67,1%) a 74,0% (95% IC 62,2-83,2%) conforme las propuestas escogidas, siendo más elevada cuando los puntos de corte eran más sensibles. El uso del IMC como criterio antropométrico no comprometió, de modo significativo, el diagnóstico de SM. A pesar de la variación, la prevalencia encontrada fue elevada alcanzando, simultáneamente, por todas las propuestas, 52,7% de la muestra. Las anormalidades más observadas fueron obesidad abdominal e hipertrigliceridemia y la menos observada fue la hiperglucemia.

Conclusión: Las alteraciones metabólicas investigadas fueron prevalentes en toda la muestra y el exceso de peso parece haber sido factor determinante en el cuadro descrito. Ese hecho denota la importancia del diagnóstico precoz y del monitoreo de esta población con el objetivo de reducir el riesgo de desarrollo de comorbidades cardiovasculares en la vida adulta joven.

Palabras clave: síndrome x metabólico; diagnóstico; obesidad; sobrepeso; niño; adolescente.

Introduction

Metabolic syndrome (MS) describes a collection of factors with a metabolic origin, such as obesity, hypertriglyceridemia, low HDL-cholesterol, arterial hypertension and glucose metabolism disorders, which are associated with cardiovascular diseases and type 2 diabetes mellitus[1]. Excess body fat causes insulin resistance which triggers the metabolic disorders that comprise MS[1]. Recent data from the World Health Organization (WHO), published in 2006, demonstrate growing prevalence of overweight all over the world; among adults and children it is estimated that around 22 million people over the age of 5 are overweight[2]. Over the last 20 years, the Brazilian population's nutritional patterns have undergone a transition and overweight and obesity among children and adolescents has risen from 4.1 to 13.9%[3].

As a diagnostic entity, MS is well-established for the adult population, but its application to children and adolescents is still a subject of discussion[4]. There is not yet an international consensus on diagnostic criteria, on cutoff limits for the variables used or on the reference curves against which to define them. Setting these parameters is a complex task because of hormonal changes that take place during growth and development and which have a metabolic effect on serum lipids and body fat distribution[5].

Prevalence studies with children have adopted the criteria used in the two most important definitions for adults: the National Cholesterol Education Program / Third Report of

the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (NCEP/ATPIII)[4] and the WHO definition[4]. The different criteria result in differing prevalence rates. Cook *et al*[6] and Ferranti *et al*[7] reported prevalence rates of 4.2% and 9.2% for the same sample of American adolescents. Weiss *et al*[8] observed that approximately 50% of severely obese patients had MS. Brazilian[9,10] studies based on the ATPIII criteria reported prevalence rates varying from 17.3% to 26.1% in obese children and adolescents.

In 2007, the International Diabetes Federation (IDF) published a new proposal, based on the principle prevalence studies that had been carried out. According to this proposal, waist circumference (WC) is the most important criterion and MS can only be diagnosed after six years of age. Between 10 and 16 years of age diagnosis includes abdominal obesity plus two of the following criteria: low HDL-cholesterol, hypertriglyceridemia, arterial hypertension or fasting hyperglycemia[11].

Despite the different criteria proposed and the absence of an accepted definition for this population, there is still evidence of the presence of risk factors for MS during childhood and adolescence. The objective of this study was to describe the prevalence of MS in an outpatients sample of overweight and obese children and adolescents, according the criteria used to define it in the literature.

Method

This was a cross sectional study of an outpatients sample of children and adolescents presenting the metabolic abnormalities that are suggested as criteria for diagnosing MS and who had been selected to take part in an intervention study undertaken at a University Hospital in Rio de Janeiro. The study was approved by the Ethics Committee at the hospital and parents and guardians signed free and informed consent forms.

Children and adolescents aged six to 17 years were selected on the basis of two or more of the following criteria: Body Mass Index (BMI) ≥P85, total cholesterol ≥150mg/dL, triglycerides (TG) ≥100mg/dL, HDL-cholesterol ≤45mg/dL, systolic and/or diastolic blood pressure ≥P90 and fasting glycemia ≥110mg/dL[12]. Subjects were classified as children (6-9 years) or adolescents (10-17 years). Exclusion criteria were neurological, hepatic or pulmonary disorders, treatment for obesity/dyslipidemia during the previous 3 months, medications containing corticoids or parental illiteracy.

All data were collected at the first consultation. Anthropometry included: weight, height and waist circumference measured according to the procedures described by Lohman *et al*[13]. Weight and height were measured using a calibrated Plenna® digital balance and an AlturaExata® stadiometer respectively. Children were classified according to their Body Mass Index percentile (P) according to the WHO curves (2007) as overweight (BMI≥85 and <P95) or obese (BMI≥P95)[14]. Body Mass Index was also converted to a z score and classified as severe obesity if above +2.5 and morbidity if above +3.0[8]. Height was classified according to the height/age (H/A) indicator, using the WHO reference (2007)[14] with the following categories: short stature ≤P3; normal ≥P10 and <P95; tall stature ≥P95.

Systolic and diastolic arterial blood pressure (BP) were measured using a BIC® sphygmomanometer using the auscultatory method, with the patient's left arm at rest, in accordance with *Sociedade Brasileira de Cardiologia* (SBC) recommendations[12] and after breakfast had been eaten.

Blood samples were taken after 12 hours' fasting and the lipid profile (TG, HDL-cholesterol and total cholesterol) was tested using a Wiener® kit. Fasting glycemia (enzymatic colorimetric method) was assayed at the hospital laboratory. Tests were performed in duplicate and the arithmetic means of the results were used for analysis.

The prevalence of MS was based on the literature, using the most prevalent criteria and cutoff points identified in a systematic review[15]. According to this review, in 28 (61%) of the articles reviewed MS diagnosis was defined as the presence of three or more of the following criteria: TG, HDL-cholesterol, glycemia, WC and BP. Other criteria cited were: BMI, TG, HDL-c, BP and oral glucose tolerance (OGT) or fasting glycemia (FG) in 7 (15.2%) articles, and TG, HDL, OGT, WC and BP in 5 (10.9%) articles. Chart 1 lists the most commonly employed cutoff points for each variable. On the basis of these data four different sets of MS classification criteria were compiled (Chart 2). Since abnormalities in the variables WC and BP are diagnosed in terms of their distribution in percentiles, classification was based on references published by McCarthy *et al*[16] and the *Sociedade Brasileira de Cardiologia* (SBC)[12]. Postprandial glycemia was excluded from all four classifications because of the technical difficulties involved with this target-population.

Data are presented in the form of descriptive statistics produced using SPSS 13.0 and Epi-Info 2000. Metabolic syndrome prevalence rate were calculated according to each of the four proposed classifications (MS1 to MS4) and differences between proportions were calculated to a significance level of 0.05.

Results

The sample comprised 74 children and adolescents, 39 (52.7%) of whom were female. Mean age was 10.1±2.3 years and 51.4% (38) were classed as children (6-9 years). The inclusion criteria meant that means for lipid profile components were outside of the limits of normality (Table 1). Anthropometry revealed a population with normal to tall height (89.2%) and obesity (70.3%), with 34 (45.9%) severely obese and 22 (29.7%) morbidly obese. Sixty-two of the 72 children and adolescents (83.8%) were in the first two Tanner sexual maturity stages.

The prevalence rates of MS according to criteria proposed in the literature were elevated, varying from 55.6 to 74.0%. Thirty-nine (52.7%) of the participants would be diagnosed as compatible with MS according to all four classifications. It was not possible to classify metabolic abnormalities for some of the children because their HDL-cholesterol (4 participants) and BP (1 participant) results were lost when the laboratory suffered technical problems.

Serum triglycerides, HDL-cholesterol and glucose were common to all four proposals and hypertriglyceridemia was the most prevalent metabolic disorder, varying from 66.2 to 74.3%. Waist circumference was larger than normal in 100% of the sample and fasting glycemia had the lowest proportion of abnormal results (1.4-2.7%) (Table 2).

Chart 1 - Cutoff points for Metabolic Syndrome components adopted for overweight or obese children and adolescents: literature review 2003-2009[13]

Component	Cutoff point	Ref Nº ARTICLES
HDL	≤40mg/dL	20
	≤50mg/dL	5
TG	≥100mg/dL	6
	≥110mg/dL	19
FG	≥100mg/dL	18
	≥110mg/dL	21
BP	≥P90	22
	≥P95	17
WC	≥P75	10
	≥P90	18
BMI	≥P85	2
	≥P95/97	13

TG: triglycerides; HDL: high density lipoproteins; FG: fasting glycemia; WC: waist circumference; BP: arterial blood pressure; TC: total cholesterol; BMI: Body Mass Index; P: percentile; Ref: reference.

Chart 2 - Proposed Metabolic Syndrome diagnostic criteria for overweight children and adolescents; derived from literature review 2003-2009[13]

Proposal	TG (mg/dL)	HDL-c (mg/dL)	FG (mg/dL)	WC	BP	BMI	Cholesterol (mg/dL)
MS1	≥110	≤40	≥110	≥P90	≥P90	-	-
MS2	≥110	≤40	≥110	-	≥P90	≥P95	-
MS3	≥110	≤40	≥110	-	-	≥P95	≥ 150
MS4	≥100	≤50	≥100	≥P75	≥P90	-	-

MS: Metabolic Syndrome; TG: triglycerides; FG: fasting glycemia; WC: waist circumference; BP: arterial blood pressure; BMI: Body Mass Index; P: percentile.

Table 1 - Distribution of anthropometric variables and biochemical test results for a sample of overweight children and adolescents.

	n	Mean	SD	Median	25th percentile	75th percentile	Maximum	Minimum
Age (years)	74	10.1	2.5	9.9	8.8	11.5	17.0	6.2
Weight (Kg)	74	53.5	18.7	51.3	40.5	60.6	120.7	21.9
Height (cm)	74	142.8	12.7	142.4	134.5	151.9	175.5	114.6
Height/Age (z score)	74	0.6	1.0	0.6	-0.02	1.2	2.9	-1.6
BMI (Kg/m²)	74	25.5	5.3	24.7	22.0	27.4	46.1	16.7
BMI/Age (z score)	74	2.6	1.0	2.4	1.9	3.1	6.2	0.85
WC (cm)	74	80.0	12.5	80.1	70.9	86.8	107.0	51.5
TC (mg/dL)	74	187.2	26.3	189.5	171.2	201.0	258.0	109.0
TG (mg/dL)	74	142.5	67.2	126.7	99.0	167.7	432.0	36.0
HDL-c (mg/dL)	70	45.7	10.6	45.0	37.0	52.0	73.0	25.0
Glycemia (mg/dL)	74	85.0	9.0	84.5	80.5	89.6	111.0	42.5
SBP (mmHg)	73	109.0	12.5	110.0	100,0	117,0	140.0	82.5
DBP (mmHg)	73	71.7	11.6	70.0	62.5	80,0	100.0	40.0

BMI Body mass index; WC waist circumference; TC total cholesterol; TG triglycerides; SBP systolic arterial blood pressure; DBP diastolic arterial blood pressure

Table 2 - Prevalence of metabolic abnormalities according to MS criteria proposed in the literature for a sample of overweight children and adolescents.

	MS1* (n= 70)	MS2*[1] (n= 72)	MS3*[2] (n= 72)	MS4*[3] (n= 73)
Total	64.3# (51.9-75.1)	55.6# (43.4-67.10)	73.6# (61.7-82.9)	74.0# (62.2-83.2)
Age				
6-9 years	51.1	50.0	47.2	51.9
10-17 years	48.9	50.0	52.8	48.1
Biochemical abnormalities				
TG	66.2	66.2	66.2	74.3
HDL-c	31.1	31.1	31.1	64.5#
BP	40.5	40.5	-	40.5
Fasting glycemia	1.4	1.4	1.4	2.7
Total cholesterol	-	-	97.3	-
Anthropometric abnormalities				
WC	100.0	-	-	97.4
BMI	-	80.0	80.0	-

#Test of difference between proportions – p=0.05; *MS1: TG≥110mg/dL; HDL-c≤40mg/dL; FG≥110mg/dL; WC≥P90; BP≥P90; *[1]MS2: TG≥110mg/dL; HDL-c≤40mg/dL; FG≥110mg/dL; BMI≥P95; BP≥P90; *[2]MS3: TG≥110mg/dL; HDL-c≤40mg/dL; FG≥110mg/dL; BMI≥P95; Cholesterol≥150mg/dL; *[3]MS4: TG≥100mg/dL; HDL-c≤50mg/dL; FG≥100mg/dL; WC≥P75; BP≥P90

No statistically significant age-dependent differences were observed in MS diagnosis. The prevalence among the children varied from 47.2% to 51.9% and was greatest according to proposals MS1 and MS4 while the prevalence among the adolescents was 48.1% to 52.8% and was greatest according to MS3.

There were differences in the proportions of MS prevalence according to the different criteria (p=0.05; Table 2). The criteria that used BMI rather than WC as an anthropometric indicator of body fat indicated the lowest MS prevalence (55.6%). The highest prevalence rates were produced by those criteria with the most sensitive cutoff points for all components (MS3 and MS4).

Discussion

The variation in MS prevalence rates according to criteria proposed in the literature was probably the result of differences in the variables and cutoff points chosen by the authors. Golley *et al*[17] also reported similar findings with 64 prepubescent children. Studies that have employed the criteria used here have reported prevalence rates from 2.1 to 58.3%[15], which are lower than those for the sample analyzed in this investigation.

The lowest prevalence (2.1%) was observed in Turkey[18], with a similar sample to the one described in the present study, i.e. Children and adolescents from six to 16 years of age at a University Hospital, using the MS4 criteria, which are considered the most sensitive, and therefore tend to identify the greatest number of children as having MS. In this Turkish study[18] all metabolic abnormalities had reduced prevalence rates, with the exception of fasting hyperglycemia (25.8%). The lower rate of excess abdominal fat (17.7%) reported in the study may be partially the result of the North-American reference curves used[19], which has parameters with lower magnitude than the British reference[16] at all ages. Notwithstanding, the authors demonstrated that 79% of their entire sample had at least one risk factor for cardiovascular disease.

Castillo *et al*[20] also used the MS4 criteria and found a 58.3% prevalence rate in Mexico, which is closer to the 74.0% observed in the present investigation. However, it should be pointed out that the aforementioned study[20] assessed people less than 25 years old, whereas the study described here only investigated children and adolescents.

In a Colombian study[21] that used the MS2 criteria, the prevalence was similar to that observed here; 58.3% and 55.6%, respectively. These similarities are due to the profiles of the populations assessed in the two investigations: children and adolescents with overweight who were invited to take part in a study of metabolic abnormalities associated with cardiovascular risk.

The MS1 criteria, which was adopted by a majority of the studies in the systematic review, indicated a median MS prevalence among the children and adolescents of the order of 31.2%[15], varying from 13.8%[20] to 51.0%[22], whereas in the present study MS1 indicated a greater proportion (64.3%). The study with the lowest prevalence in the

systematic review[23] was conducted with low socioeconomic status schoolchildren from a public school and the study reporting the greatest prevalence analyzed children and adolescents taking part in a metabolic investigation at an American hospital. It will be noted that the prevalence rate closest to that reported here comes from a study population recruited at a hospital.

Including total cholesterol as a variable in the diagnostic criteria for MS resulted in a similar prevalence to the MS4 criteria that were based on the NCEP/ATPIII classification for adults[24], but with more sensitive cutoff points. The high prevalence of hypercholesterolemia (97.3%) was the result of inclusion criteria with a low cutoff point, as recommended by the SBC[12]. Although cholesterol is not considered a criterion for MS, its inclusion is particularly important in the target-population, because of the effect on the process of atherosclerosis.

Two studies[25,26] were conducted in Turkey using the MS3 criteria and the observed prevalence of MS was 27.2 and 41.8%, but some of the cutoff points were altered, which may have affected the estimates.

Comparison with the results of other Brazilian studies shows that the metabolic abnormalities reported here are more severe. Buff *et al*[27] studied obese children in São Paulo and found MS in 42.4% using the MS1 criteria, but with used a lower cutoff point for glycemia (100mg/dL). In contrast, in Brasília Ferreira *et al*[9] found a prevalence of 17% among children at public schools, but they had altered the MS2 criteria, lowering the cutoff points for glycemia (100mg/dL) and for HDL-cholesterol (40mg/dL). It is the reduction of the HDL-cholesterol cutoff point that may have contributed to the reduced prevalence. In another two studies undertaken with children and adolescents in São Paulo, the prevalence rates varied from 20.6%[28] to 34.5%[27], with the second of these based on a higher TG cutoff point (130mg/dL).

In summary, the differences in estimated MS prevalence according to criteria proposed in the literature maybe partially attributable to the general characteristics of the samples being compared in terms of age group, ethnicity, anthropometry and the type of institution where the studies are conducted. Equally, the heterogeneous nature of the criteria employed to define MS in childhood and adolescence should also be considered, whether the differences are in terms of which variables should be used as criteria or in terms of the cutoff points and reference curves most appropriate for children and adolescents.

When the sample was stratified by age, it was observed that MS prevalence was very similar for both children and adolescents (differences not statistically significant). The IDF[11] recommends that a diagnosis of MS should only be made from adolescence on. However, this study shows that metabolic abnormalities can be detected in younger age groups and should be identified and monitored in order to trigger early intervention and to make it possible to control progression. Notwithstanding, age is a factor that must be taken into account when diagnosing metabolic abnormalities. Puberty has an effect on insulin metabolism, caused by sex and growth hormones, and transitory insulin resistance may be observed, with increased serum levels, a greater disposition towards adipose tissue deposition and changes to the lipid profile[29,30].

Ethnicity and race also appear to be related to the components of MS. Weiss *et al*[8] and Cook *et al*[6] found lower prevalence among blacks than among whites in a population of American children and adolescents. White children and adolescents had worse lipid profiles than blacks who, in turn, had higher blood pressure and lower sensitivity to insulin[31]. Considering ethnicity, South-Asians and Hispanics appear to have increased susceptibility to MS, possibly because of the increased frequency of insulin resistance in these ethnic groups[32]. In Brazil, it is relatively difficult to define the ethnicity of patients because of the high degree of racial admixture.

The abnormalities most frequently observed were abdominal obesity and hypertriglyceridemia, with fasting hyperglycemia the least prevalent. Similar results have been found in other studies[7,10]. These findings are probably the result of the sample, which was made up of overweight and obese people whose excess body fat is associated with metabolic abnormalities, which in turn are of importance as precursors of insulin resistance. This condition provokes changes in lipid and glucose metabolism, including increased hepatic triglyceride production and reduced level and size of the HDL-cholesterol fraction, particularly type 2. Furthermore, insulin resistance is involved in the development of arterial hypertension through mechanisms of renal resorption of sodium and water, activation of the sympathetic nervous system and nitric oxide production[33]. A high prevalence of low HDL-cholesterol was also observed, particularly when the cutoff point was more sensitive (<50mg/dL). When the lower cutoff point was used (40mg/dL), the proportion reduced

by almost half (31.1%), although this remains a level that is considered elevated.

The reduced prevalence of fasting glycemia abnormalities in all of the studies analyzed may indicate that this is not an appropriate variable for detecting metabolic abnormalities caused by overweight in children and adolescents. It is widely used because of ease of application, however, in this population, glucose metabolism abnormalities should be detected by testing oral glucose tolerance. Studies that have assessed this variable found prevalence rates of abnormal results varying from 4.6% to 27%[34,35]. It is important to point out that this test is less likely to be used with children because two blood samples must be taken with a 2-hour interval.

Two anthropometric variables were used in this study, BMI and WC. WC is considered a good anthropometric predictor of MS[32] because it assesses the visceral adiposity associated with insulin resistance[36]. The 90th percentile is the most often chosen cutoff point[7,34], but can vary according to age, sex and ethnicity[36]. However, in contrast with BMI, there is no normative standard, only references derived from specific populations[24,33], which makes comparisons between different studies difficult. It would be helpful to produce a single reference standard, by sex, age and ethnic group, with standardized measurement methods, associating it with adverse health events.

Irrespective of the anthropometric variable used, the sample analyzed had excess body fat. Although BMI does not differentiate fat mass from fat free mass, an elevated BMI cannot be considered as an increase in muscle mass. Therefore, researchers working in the area should consider using BMI for diagnosis of MS because of its practicality and because of the existence of WHO-recommended international reference standards.

Certain limitations mean the results of this study should be interpreted with caution. These include the sampling process and sample size, with the possibility that population representativeness of the universe of overweight and obese children and adolescents was not achieved. Furthermore, studies with children and adolescents are more complex operationally, particularly with relation to drawing blood at two different times on the same day in order to carry out the oral glucose tolerance test. On the other hand, the study may serve to highlight the methodological difficulties involved in attempting to determine abnormalities that indicate MS in childhood and adolescence, as demonstrated by the heterogeneous nature of the estimates of prevalence. As a result, it is difficult to establish which criteria are best for detecting abnormalities associated with risk to cardiovascular health.

This investigation has shown the importance of reaching an international consensus on the presence or absence of this syndrome in children and on which are the best criteria for diagnosing it. The study adds further weight to calls already made by other authors for the development of references and cutoff points to indicate adverse health effects in the pediatric population[36].

Irrespective of the proposed criteria employed, elevated prevalence rates were observed for MS and metabolic abnormalities such as hypertriglyceridemia, high blood pressure and low HDL, associated with excess abdominal fat in obese children under observation. This profile underscores the importance of early diagnosis and monitoring of these abnormalities in the target-population, with the aim of reducing the risk of development of cardiovascular comorbidities in early adulthood. Despite the divergences over criteria, there is a pressing need for a proposal that is accepted by the scientific community for assessment and follow-up of obese children and adolescents and which should be used as a basis for clinical practice and for planning and implementation of public health policies.

Acknowledgements

We would like to thank the team at the Clinical Analysis Laboratory at the HUGG/UNIRIO and we are especially grateful to João Dario do Carmo Machado, Marcella Alessandra Galhanone and Marlene Barbosa Marinheiro for their efforts collecting and analyzing test samples. We would also like to express our gratitude to the HUGG administration for their generous provision of laboratory analyses, despite the financial difficulties involved. Finally, we would like to thank the undergraduate students from UNIRIO who helped to provide care at the HUGG pediatric nutrition clinic.

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