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Prevalence of factors associated to metabolic syndrome in a cohort of children in South Brazil

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Abstract

Introduction: **the Metabolic Syndrome is a group of disorders and it has gaining importance due to its association with the subsequent development of cardiovascular diseases.**

Objectives: **to determine the prevalence of risk factors associated to the metabolic syndrome in children from a cohort in Southern Brazil.**

Methods: **a prospective cohort study with hospital screening of all births (2741) occurred from September 2002 to May 2003, monitoring a random sample of 30.0% at one, three and six months and eight years old. During the visit at the age of eight years, a questionnaire containing questions related to nutrition, physical activity and family history of chronic diseases. Also, weight, height and the waist circumference were measured. Descriptive and bivariate analyzes between independent variables and the outcome were performed.**

Results y discussion: **from the 616 studied children, 51.3% were male, 70.3% had white, about half belonged to the economic class C, 20.5% were overweight and 16.9% were obese. There was high prevalence of family history for hypertension (81.5%), and was observed that 20.7% of the eutrophic children showed elevated waist circumference. Conclusion: the high prevalence of risk factors for the metabolic syndrome found in the studied children reinforces the importance of proper medical history including family history. It is suggested to include the measurement of waist circumference in routine pediatric care.**

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Key words: *Metabolic syndrome. Obesity. Waist circumference.*

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PREVALENCIA DE FACTORES DE RIESGO ASOCIADOS CON EL SÍNDROME METABÓLICO DE LOS NIÑOS EN UNA COHORTE EN EL SUR DE BRASIL

Resumen

Introducción: **el síndrome metabólico es un grupo de enfermedades que ha ido ganando importancia debido a la asociación con el desarrollo posterior de enfermedades cardiovasculares.**

Objetivo: **verificar la prevalencia de factores de riesgo asociados con el síndrome metabólico en niños de una cohorte del sur de Brasil.**

Métodos: **estudio de cohorte prospectivo con el hospital de todos los nacimientos (2.741) que tuvieron lugar en el mes de septiembre/2002 a mayo/2003 y seguimiento de una muestra aleatoria de 30,0% con uno, tres y seis meses y ocho años de edad. En una visita a los ocho años de edad se utilizó un cuestionario con preguntas relacionadas con la nutrición, la actividad física y la historia familiar de enfermedades crónicas, y se midieron peso, talla y circunferencia de la cintura. Se realizaron análisis descriptivos y bivariados entre las variables independientes y los resultados obtenidos.**

Resultados y discusión: **de 616 niños estudiados, el 51,3% fueron varones, el 70,3% blancos, cerca de la mitad pertenecían a la clase económica C, el 20,6% tenían sobrepeso y el 17,0% eran obesos. Mostró una alta prevalencia de historia familiar de hipertensión arterial (81,5%), y se observó que el 20,7% de los niños eutróficos tenían una circunferencia de cintura elevada.**

Conclusión: **la alta prevalencia de factores de riesgo para el síndrome metabólico en los niños estudiados refuerza la importancia de una adecuada anamnesis: historia familiar. Se sugiere medir la circunferencia de la cintura en la rutina de cuidados pediátricos.**

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Palabras clave: *Obesidad. Síndrome metabólico. Circunferencia de la cintura.*

Abbreviations

MS: metabolic syndrome.
HDL: high density lipoprotein cholesterol.
CVD: cardiovascular diseases.
T2DM: type 2 diabetes mellitus.
IDF: International Diabetes Foundation.
HTN: hypertension.
HIV: Human Immunodeficiency Virus.
RR: relative risk.
BMI: body mass index.
WC: waist circumference.
ABEP: brazilian association of companies and research.
WHO: World Health Organization.
PAQ-C: physical activity questionnaire for children.
UCPEL: Catholic University of Pelotas.
PR: prevalence ratio.

Introduction

The Metabolic Syndrome (MS) is a group of disorders that includes obesity, high levels of triglycerides, low levels of High Density Lipoprotein Cholesterol (HDL), hypertension and insulin resistance, and it has gaining importance due to its association with the subsequent development of cardiovascular diseases (CVD) and type 2 diabetes mellitus (T2DM)[1]. The MS is highly prevalent in adults, and the coexistence of these multiple variables of cardiovascular risk also occurs frequently in children[2].

The definition of the Metabolic Syndrome in childhood and adolescence is problematic, since blood pressure, lipid profile and anthropometric values vary with age and pubertal status, and different cut-offs for age and sex should be used for each one of the variables. Although the prevalence of the MS in children is inereasing, there is no consensus on the criteria and cut-offs to be used, varying from study to study[3]. The International Diabetes Foundation (IDF) proposed a definition of the metabolic syndrome in childhood and adolescence and, according to the proposed criteria, it is not possible to diagnose the MS in children younger than 10 years, but it is possible to evaluate the presence of risk factors in children 6 to 10 years old through the waist circumference measurement (WC) and the presence of a family history for MS, T2DM, dyslipidemia, CVD, hypertension (HTN) and/or obesity[3]. But regardless the criteria used, studies show a correlation between obesity and the prevalence of MS[1-2]. This fact, in addition to the current epidemic of childhood obesity, generates an increase of CVD in childhood, besides the development of T2DM and, consequently, the lower survival of population[4].

Obesity is characterized by the excessive accumulation of body fat at a level that it compromises individuals health, causing damages including metabolic disorders, breathing difficulties, dyslipidemia, CVDs, type 2 diabetes and some types of cancer[5]. The presence of overweight/obesity appears as the most important risk factor for the metabolic syndrome and, in Brazil, the prevalence of overweight in children and adolescents has tripled over the past decades[6]. According to recent evaluations, 17% of children aged between 2 and 19 years old are overweight[6]. Despite the prevalence of CVD and MS in children are low, their occurrences have the most important risk factor in the excess of body fat, so its effects are greatly increased in obese children[7]. Studies show prevalence over 30% of the MS in obese children[2,7].

Low birth, weight and inappropriate nutrition, rich in easily absorbed carbohydrates, with high lipid content and low in dietary fiber, along with sedentary lifestyle, help the emergence of overweight/obesity, high blood pressure, dyslipidemia and T2DM, and increase the probability of developing the MS[8]. Given this context, the aim of this study is to assess the prevalence of factors associated to the risk of metabolic syndrome in children from a cohort in South Brazil.

Methods

This is a prospective cohort study, which presented two components: perinatal (hospital screening) and monitoring (home visits at one, three and six months old and eight years old). During the period of study, there were 3449 births, with 81.0 % (2799) of infants residing in the urban area of Pelotas. Among them, 29 were born outside the hospital, but they were included in the study for having been sent there soon after the delivery. Ten children were discharged earlier from the hospital, and could not be located later. Also, 26 mothers were excluded because they were positive for *Human Immunodeficiency Virus* (HIV) once the main objective of the cohort study was to examine aspects related to breastfeeding, and 22 refused to participate. Therefore, in hospital screening, the final interviewed population was of 2,741 mothers, representing 98.0% of all births in the target population. From this sample, 30.0 % (973) were randomly selected, through a statistical program, for home care monitoring in the first, third and sixth month of life and at eight years of age.

The sample was calculated aiming an analysis based on 95.0% of confidence level and 80.0% of statistical power for exposures, ranging from 15 to 80%, and estimating a relative risk (RR) of 2.0 and increase of 15% to the initial calculation for losses and control of confusing factors. In the first month of the investigation, 951 questionnaires were responded; 940 in the third month and 931 in the sixth month, with 2.3%, 3.4% and 4.4% of losses, respectively. While monitoring at eight years of age, 616 children were visited (63% of the initial sample). There were five refusals, 17 deaths, 93 children moved to other states/cities and 242 whose addresses were not found.

All infants born from mothers living in the urban area of Pelotas and that presented no serious problems that would contraindicate breastfeeding were considered eligible for the inclusion in the study. For the monitoring at eight years old, all children from the cohort who were visited at six months old, living in the urban area of Pelotas, were included.

Data about the methodology of the cohort and from the surveillance in the 1st semester of life are published[9]. For the visit at eight years of age, a standardized questionnaire was applied to mothers or caregivers, containing questions about health and eating habits.

The studied variables were: gestational age at birth, birth weight, body mass index (BMI) at the age of eight years old, physical activity practice, socioeconomic factors (family income, maternal education and socioeconomic status, according to Brazilian association of companies and research, ABEP[10]) and the number of children. The variables collected in order to characterize the prevalence of risk factors for the MS were: WC measurement and family history of diabetes, hypertension, overweight and/or obesity, dyslipidemia and CVD[3].

For the anthropometric assessment at eight years old, the child was weighed and measured with portable and precision equipment. The weight was measured using a Tanita® scale, model UM-080 Body Fat Monitor/Scale and the height with a wooden stadiometer. Overweight and obesity were classified according to the standards of the World Health Organization (WHO) from 2007[11]. Touse them, the BMI was calculated as a diagnostic criterion for overweight and obesity, rated as recommended by WHO[10], being considered overweight children with BMI for the age > +1 z score and obese > +2 z score.

According to the criteria of IDF[3], the measurement of the WC was taken to assess the risk of the MS, measured by an inextensible tape, graded in millimeters, midway between the tenth rib and the iliac crest, in which were considered inadequate the values equal or greater to the 90th percentile. Each one was asked about familiar occurrence of diabetes, hypertension, overweight and/or obesity, dyslipidemia and CVD among parents, uncles/aunts and grandparents.

For the physical activity assessment, we used the Physical Activity Questionnaire for Children (PAQ-C)[12] instrument, in which the classification is given according to physical activity scores from 1 (very sedentary) to 5 (very active). The anthropometric data (weight, height and waist circumference) were analyzed by gender and age on the day of assessment.

The quality control was conducted through questionnaires and instruments previously tested, and through the repetition of questions in synthesized questionnaires in a random sample of 10.0% of all the children. The questionnaires were entered into a database built using the Epi Info 6.0 d® program. The calculation of the frequency of the variables of interest was performed, after bivariate analysis between the independent variables and the outcome. Were performed, using the chi-square test. After the analysis, only variables with $p < 0.05$ were considered statistically significantly associated with the outcome. Missing data were not included in the analysis and the maximum of ignored information was of 13 (family income).

The research project was approved by the Ethics Committee from Catholic University of Pelotas (UCPEL) and the mothers or guardians signed a new term of the Informed Consent, since the visit at eight years of age was not planned in the original design of the cohort. During this visit, the mothers received a printed copy of the Food Guide to the Brazilian population[13] and the children who were identified as having health problems were sent to medical care.

Results

While monitoring children at eight years old, 616 children were interviewed, 51.3% of those were male, 70.3% had white, 92.0% were born weighing more than 2500g and 10.7% with the gestational age lower than 37 weeks. Regarding maternal education, 34.6% had finished high school and 8.6% had a university degree (Table I).

The anthropometric nutritional assessment identified that 20.5% of the children were overweight, being 19.6% of boys and 21.7% of girls. About obesity, it was observed in 16.9% of the sample, 19.9% of boys and 14.0% of girls. Thus, the prevalence of excessive body weight in the sample was 37.4%. Among the overweight children, 37.0% had WC ≥ 90th percentile, while in the obese this growth was present in 84.7%.

Table II shows the prevalence of risk factors for the MS and it was found that 81.5% had a positive family history of hypertension. When analyzing the waist circumference, it was found that 24.0% of the children had value ≥ 90th percentile, i.e. higher than recommended.

It was observed that 20.70% of the eutrophic children had the percentile of the WC > 90. Children with overweight and obesity, showed percentages of 37.0% and 84.7%, respectively, with prevalence ratio (PR) of 1.79 and 4.09 ($p < 0.001$).

Table III shows the analysis between the WC and the sociodemographic variables and found a statistically significant association for the variables: child's color, gender, family income and socioeconomic class. There was no statistically significant association to: birth weight, gestational age, physical activity, duration of breastfeeding and parental education (data not shown in the table).

Discussion

Among the predisposing factors for the MS, low birth weight is associated with overweight and obesity in

Table I
Characteristics of the studied sample, Pelotas, RS, Brazil, 2011

Variable	*n*	*%*
Child's gender		
Male	316	51.3
Female	300	48.7
Ethnicity		
White	433	70.3
Non-white	183	29.7
Family Income[a]		
≤ 1	85	13.8
1,01-3	308	50.0
3,01-6	144	23.4
>6	66	10.7
Ignored	13	2.1
Economic Class[b]		
A	24	3.9
B	202	32.8
C	325	52.8
D and E	65	10.5
Maternal Education		
Illiterate/Elementary 3rd grade	34	5.5
Elementary School 4th grade completed	176	28.6
Middle School	133	21.6
High School	213	34.6
Higher Education	53	8.6
Ignored[c]	7	1.1
Gestational Age at Birth		
< 37 weeks	66	10.7
> 37 weeks	550	89.3
Birth weight		
< 2500g	49	8.0
≥ 2500g	567	92.0
BMI classification		
Underweight	12	1.8
Eutrophic	374	60.8
Overweight	126	20.5
Obesity	104	16.9
Physical Activity		
Scores 1 and 2	438	71.3
Scores 3 and 4	177	28.7
Score 5	-	
Total	616	100.0

[a]in minimum wages. [b]Economic Class= A1 and A2 higher economic class and D and E= lower economic class. [c]children who do not live with the mother.

Table II
Prevalence of risk factors for the metabolic syndrome in children from a cohort of southern Brazil, 2011

Variable	*n*	*%*
Waist circumference		
< 90th percentile	468	76.0
≥ 90th percentile	148	24.0
Family history of diabetes mellitus		
Yes	303	49.2
No	313	50,8
Family history of obesity or overweight		
Yes	299	48.5
No	317	51.5
Family history of cardiovascular disease		
Yes	340	55.2
No	276	44.8
Family history of hypertension		
Yes	502	81.5
No	114	18.5
Total	616	100.0

childhood. This may be due to biological aspects, related to the hypothesis of fetal programming, or the influence of postnatal factors on the risk of obesity such as the weight gain during childhood, or the speed of the growth in the development of childhood obesity[14]. In this population, the low birth weight was present in only 8.0%. As to the economic status, it was found that about half of the children belonged to class C, and the relationship between the obesity and the lowest economic class level is observed in countries under development, because the healthier foods are less available for this population[7].

The identification of risk factors is a priority to prevent the progression of the MS into a serious medical event. Family history of Diabetes Mellitus, dyslipidemia, CVD, and overweight and obesity were reported by almost 50%. It was found high prevalence of family history of hypertension (81.5%): 16.4% maternal and 10.2% paternal. Grandparents were the relatives most affected by the studied diseases. The presence of cardiovascular events or risk factors in closest relatives predicts higher risk in children[14]. The incidence of the T2DM in childhood and mainly in adolescence is increasing and the family history is strongly associated to the onset of the T2DM in both adults and youths[15].

Among all risk factors for the MS, the presence of overweight /obesity appears to be the most important[16]. Considering this, the large number of excessive weighted children is highlighted, given that 20.5% were overweight and 16.9% were obese. Studies show that obesity is the unique factor routinely associated to the clustering of risk factors, Also, they reported the strong effect of maintaining the childhood obesity for the adult phase[16-17]. It is worth to mention that there is an association between hypertension and obesity in any age groups[17]. In the infant population, obesity is a major cause of hypertension and the systolic hypertension correlates positively with the BMI[18].

There is evidence that the infant overweight and obesity tend to persist into adulthood. Half of overwei-

Table III
Waist Circumference in relation to sociodemographic variables, 2011 (n=615)

	Waist Circumference Percentile<90 n (%)	*Waist Circumference Percentile ≥ 90 n (%)*	*Prevalence Ratio (PR)*	*p*
Child's color				
Non-white	153 (78.6)	30 (16.4)	1.00	0.004
White	314 (72.7)	118 (27.3)	1.67 (1.16-2.39)	
Child's Sex				
Male	224 (70.8)	92 (29.2)	1.55 (1.16-2.08)	0.006
Female	243 (81.2)	56 (18.8)	1.00	
Economic Class[a]				
A	17 (70.8)	7 (29.2)	2.33 (0.95-5.74)	0.02
B	136 (67.3)	66 (32.7)	2.61 (1.33-5.15)	
C	258 (79.4)	67 (20.6)	1.65 (0.83-3.26)	
D and E	56 (87.5)	8 (12.5)	1.00	
Family Incomeb				
< or = 1 MW	68 (80.9)	16 (19.1)	1.00	0.006
1,01 to3 MW	246 (79.9)	62 (20.1)	1.06 (0.64-1.73)	
3,01 to 6 MW	95 (65.9)	49 (34.1)	1.79 (1.09-2.93)	
> 6 MW	47 (71.2)	19 (28.8)	1.51 (0.84-2.71)	
Total	467 (75.9)	148 (24.1)		

[a]Economic Class = A higher economic class, D and E = lower economic class [b]MW = Minimum wage

ght adolescents and more than one-third of overweight children remain obese as adults, providing long-term effects on mortality and morbidity[19-20].

The waist circumference (WC) is considered an independent predictor condition of cardiovascular risk in adults and children, and children with the WC above the 90th percentile are more susceptible to multiple risk factors and, in this study found a percentage of 24% of children with increased WC. Studies in children suggest that the WC has a greater relationship with other parameters of the metabolic syndrome, such as the insulin resistance, hypertension and dyslipidemia[16-17]. Alberti et al. suggest that the MS should not be diagnosed in children younger than 10 years, but the weight reduction and lifestyle change should be strongly recommended for those with abdominal adiposity[21], since several studies show that children with a waist circumference greater than the 90th percentile are more predisposed to the CVD[16-19].

The ability of both the WC and the BMI as predictors of the MS confirms the strong association of body fat to the outcome of the phenomenon, since the body fat, especially the abdominal, is related to the insulin resistance and other aspects associated with the MS[22].

Besides the increase in obesity, another risk factor for the MS is the increase in sedentary lifestyle in all age groups, which may foster the emergence of changes related to the glucose and lipid metabolism and the increase in blood pressure, known as important risk factors for the CVD[22]. The fact that 71.3 % of children presented scores one or two in PAQ – C, related to physical activity, was worrying, which demonstrates that the vast majority are sedentary or little active. Currently, children and adolescents are exercising their selves less, due to a greater attraction by the television, electronic games and computers, combined with a few hours assigned to physical activities in schools[16]. Moderate levels of regular physical activity exert a protective effect on metabolic risk factors[23]. Thus, it is clear the importance of physical exercising on the prevention and as a helper in the treatment of the MS[23].

It is known that physical inactivity is one of the most important factors for the development of chronic diseases and, when present in the childhood, it tends to persist in the adult life[24]. Sedentarism causes serious negative consequences to health throughout the life cycle. It is a fundamental element in the approach for the prevention and treatment of major chronic non transmitted diseases, and in health promotion. Therefore, physical inactivity represented important public health problem[25].

Analyses have shown the relationship between the BMI and the increase in the WC. About 37% of the overweight and 84.7% of the obese children had WC ≥ 90th percentile. A study conducted by Ricco et al. found prevalence of 14% of overweight children and

50% of obese children with altered WC[26]. Damasceno et al. showed that 9.3% of the children with adequate nutritional status, 89.2% of the overweight infants and 95.8% of the obese children had central obesity and the study showed that even eutrophic infants presented elevated levels of central adiposity, which is worrying given the risks for non transmitted chronic diseases[27]. The WC is the measure that best represents the distribution of visceral fat and this, on the other hand, is more closely linked to metabolic changes than subcutaneous fat, indicating the risk of the child to develop a cardiovascular disease in the future life[26].

A limitation of the study is related to the difficulty of establishing a definitive diagnosis of the MS for this age group, because there are no guidelines on the subject. The results indicate that it is high the prevalence of risk factors for the MS in the studied children, since they have a high WC measure and family history for most of the chronic diseases, especially hypertension. Given this, it is suggested to introduce in pediatric practice the control of the WC measure and to compare it with reference values, an unusual practice in pediatric visits, and an adequate anamnesis, including family history.

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