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Annals of Pediatrics & Child Health

Research Article

Anthropometric and Metabolic Profile of Schoolchildren Born Full Term or Preterm: A Cross-Sectional Study

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Submitted: 26 January 2021

Accepted: 19 February 2021

Published: 22 February 2021

ISSN: 2373-9312

Keywords

- Childhood obesity
- Metabolic syndrome
- Child health
- Cardiovascular disease
- Metabolic disease

Abstract

Facing an increase in childhood obesity, it is necessary to investigate the metabolic profile of school-aged children in order to identify earlier lipid and glycemic changes. The objective in this study was to establish the blood pressure, anthropometric and metabolic profile of school-age children born at term or premature in western Paraná. The methodology implemented in this article was a cross-sectional, convenience-type sample of 132 children (five to nine years old), from four municipal schools, 33 children from each school were selected for data collection. Family socioeconomic variables, weight, height, waist circumference, blood pressure, total cholesterol, triglycerides and glucose were analyzed. The schoolchildren were divided into two groups: born at term (GENT), and premature births (GENP). Statistical analysis using XLSTAT. The main results obtained showed that overweight and obesity were observed in the GENT (38.33%), and GENP (41.66%). Statistical difference was observed only in the abdominal circumference in the GENT, of these, 90% had mean systolic blood pressure above the 90th percentile ($p<0.001$), 65% had clinical criteria for metabolic syndrome. In conclusion, anthropometric profile showed a significant prevalence of obesity in both groups, waist circumference higher than expected for age. Lipid parameters should be routinely evaluated among schoolchildren, looking for changes to propose interventions to reduce the risk of chronic conditions in adulthood.

INTRODUCTION

Every decade there has been an increase in the obesity prevalence, starting in childhood and extending to adulthood. Thus, contributing to the increase in cardiovascular and metabolic diseases – main causes of hospitalization and death in adults. The forecast, according to the World Health Organization (WHO), is that in 2022 there will be more obese children and adolescents than with moderate malnutrition [1].

The population's obesogenic environment is the main cause of increase in obesity and overweight, which is characterized by nutritional change (diets high in fat, sugar and processed foods and low in complex carbohydrates and fibers), due to environmental aspects, and psychosocial and cultural factors [2]. Another aspect to consider is the presence of a hostile intrauterine environment, with decreased nutrient supply and the presence of stressors that can trigger premature birth and low birthweight, being a risk factor for the occurrence of chronic diseases in adulthood, including cardiovascular and Type 2 Diabetes Mellitus - T2DM [3].

Recent study shows that schoolchildren born extremely low birthweight (under 1.000 grams), seem to have increased abdominal visceral fat compared with those born very low birthweight (under 1.500 grams) [4]. They will be adults potentially presenting diseases associated with metabolic syndrome – MS [3,5]. The predisposition to MS associated with an increased risk of cardiovascular events is directly related to childhood obesity, resulting in an increased predisposition to diseases such as: T2DM, systemic arterial hypertension and dyslipidemia [6]. However, there is still no diagnostic criteria for pediatric MS well defined by the Brazilian Diabetes Society [6], especially for diagnosis in children under 10 years old [7].

The definition of infantile MS is challenging and controversial, since more than 40 definitions - the majority based on adaptations of criteria for adults - have already been proposed, with none so far having been universally accepted. However, they share some common criteria, such as: the obesity estimates by body mass index (BMI) or waist circumference (WC); blood pressure level (BP); serum triglycerides (TG), LDL cholesterol (LDL-c), and/or HDL cholesterol (HDL-c) levels; and an insulin resistance indicator - fasting blood glucose, glucose tolerance or insulin [8].

In this sense, it is urgent to diagnose excess weight early, as well as metabolic changes, from prompt age. This assessment, which is performed routinely in school's health consultations, may make it possible to propose interventions appropriate to the unique needs of this group, in order to prevent them from becoming obese adults and their comorbidities. Therefore, this study aims to establish the anthropometric, blood pressure and metabolic profile of schoolchildren born full term and preterm in a municipality south if Brazil.

MATERIALS AND METHODS

This is a quantitative study of a cross-sectional design, developed in schools in a municipality of south of Brazil. Children aged 5 to 9 years old from four municipal schools were evaluated. The total number of children in this age group in the municipality, in 2018, was 8156, of these 4129 were male [9], constituting the study population.

The study sample was 132 children, composed of 33 children from each school included in the study. Aiming to include all schools in the municipality to compose the sample, student stratification by family income in low and medium income was made, including two schools from each stratum, since the economic factor could be a bias for sample selection. After selecting schools, children from each school in the study field were selected, which were allocated to the sample after authorization by the guardians through an information letter and a consent form signed by them. Of the total of 132 children in the sample, 130 were born full term and 12 were premature (9%), i.e., those with gestational age under 37 weeks. Thus, the total sample was divided into two groups: group of schoolchildren born full term (GSFT), and group of schoolchildren born prematurely (GSP).

Data collection took place in a private setting designated by the school itself and performed by a group of trained collectors under supervision of the main researcher. Children were first interviewed using the research form adapted from the instrument by Lopes et al. [10]. containing family and child sociodemographic variables. Subsequently, anthropometric measurements (weight, height, waist circumference - WC, with subsequent Body Mass Index – BMI calculation, and blood pressure - BP), were measured. Afterward, capillary collection was performed for analysis of Total Cholesterol (TC), Triglycerides (TG) and Postprandial Glycemia (PPG).

The Leader® portable digital scale (Araçatuba, São Paulo, Brazil), model P200m, with a maximum capacity of 200 kg, was used to measure the weight. Height was verified with a Sanny® wall stadiometer (São Bernardo do Campo, São Paulo, Brazil), Standart model, with a scale in millimeters, and WC was checked with an inelastic measuring tape. The BP measurement followed the 7th Brazilian Guideline for Hypertension [11], using the Onrom® digital wrist sphygmomanometer (São Paulo, São Paulo, Brazil). According to the percentile of height for age and gender, after BP was measured, the average of the two measurements was calculated and classified according to reference tables for gender and age [12].

From weight and height measurements, BMI was calculated according to the formula BMI = W/H^2 (weight divided by height squared), and the classification was made according to the Z-score cut-off points, as recommended by WHO and adopted by the Ministry of Health [13].

WC measurement consisted of placing the measuring tape at the midpoint between the lower margin of the last rib and the upper border of the iliac crest and was classified into percentiles according to gender, age and race through the Freedman, Srinivasan, Berenson [14], reference. Children with WC ≥ 90^{th} percentile was considered at risk for MS, according to International Diabetes Federation [6].

Blood samples were collected using digital puncture, using G. TECH automatic lancets (Jinan city, China). The puncture was performed on the digital pulp side of the left hand's fourth finger. For PPBG, the G. TECH Free Lite® device (Jinan city, China) was used. Individuals with normal glucose tolerance should have glycemia between 80 and 126 mg/dL. However, as there are no blood glucose cut-off points for children under 10 years old to diagnose MS, it was decided to follow the Brazilian Diabetes Society guidelines, in order to compare blood glucose results indicating blood glucose > 100 mg/dL as a criterion for children over 10 years old [6].

The collected data were entered into Excel for Windows 2010, with database double checking, analyzed in the XLSTAT program. Data analysis was performed using descriptive statistics; the sample was characterized by calculating the mean, standard deviation, median, confidence interval, absolute and relative frequency and p-value. The analysis of variables related to the anthropometric, blood pressure, glycemic and lipid profile was carried out comparing GSFT and GSP.

The data of characterization variables for BMI were classified and analyzed according to the percentiles and Z score of reference for the child's age [13]. For the pressure profile analysis, references for gender and age were used [12]. Regarding the glycemic profile data, the DBS guidelines [6], and for the lipid profile the guidelines by Scartezini et al. [15], so that it was possible to identify changes in these criteria.

To analyze the association between qualitative variables, the Chi-square test for independence was performed. The study obeyed all ethical precepts and was approved by the Ethics and Research Committee.

RESULTS

The sample characterization is described in Table 1. Regarding sociodemographic characteristics of the sample under study, the only one that did not present statistical differences ($p > 0.05$), between expected and observed values was the gender variable.

The characterization of anthropometric, blood pressure, glycemic and lipid profiles of GSFT and GSP students described in Table 2 revealed that, although the highest frequency in both

Table 1: Sample characterization regarding sociodemographic variables of full term and preterm children aged between 5 and 9 years. Toledo-PR, Brazil, 2019. (N = 132).

Variables	Categories	FA*	FR%**	p-value***
Child's age (years)	5	15	11.36	<0.0001
	6	24	18.18	
	7	34	25.76	
	8	39	29.55	
	9	19	14.39	
Sex	Male	63	47.73	0.602
	Female	69	52.27	
Race	White	92	69.7	<0.0001
	Brown	37	28.03	
	Black	3	2.27	
Child's education	Pre-two	15	11.36	<0.0001
	1st year	20	15.15	
	2nd year	34	25.76	
	3rd year	45	34.09	
	4th year	15	11.36	
	5th year	3	2.27	
Mother's occupation	Unemployed	6	4.65	<0.0001
	Employment relationship	65	50.39	
	Public servant	9	6.98	
	Housewife	32	24.81	
	Self-employed	17	13.18	
Father's occupation	Unemployed	6	5.17	<0.0001
	Employment relationship	73	62.93	
	Public servant	4	3.45	
	Self-employed	33	28.45	
Income (minimum wage)	1 or less	19	14.84	<0.0001
	2 to 3	88	68.75	
	Over 4	21	16.41	
Number of income dependents	1	13	10.92	0
	2	38	31.93	
	3	29	24.37	
	4	25	21.01	
	5 or more	14	11.76	
Number of persons per household	Up to 2	6	4.62	<0.0001
	5-Mar	117	90	
	6 or more	7	5.38	

* FA= absolute frequency; ** FR= relative frequency; *** p-value from the adhesion's chi-squared test.

groups was of eutrophic children, a significant percentage of schoolchildren were overweight for age in both groups, with a higher prevalence in GSP (41.66%). The WC, for 16.67% of GSFT was higher than expected for their age, according to reference percentiles. The sample blood pressure profile showed a higher frequency of schoolchildren with age-appropriate BP. Among GSFT schoolchildren, 13.33% had TG values and 8.33%, TC values above the reference for age. The glycemic profile showed that both groups had PPG above the reference values, with the highest frequency being identified among GSP students (Table 2).

When variables were classified in percentiles and reference Z-scores presented in Table 3, only the WC percentile presented a statistically significant association between both groups (p = 0.028).

From the identification of sample percentage with WC

Table 2: Classification of variables related to anthropometric, blood pressure, lipid and glycemic profiles, according to the Z-score and reference percentiles for age. Toledo-PR, Brazil, 2019. GENT (N = 120) and GENP (N = 12).

Variables	Categories	n(%)	p-value*
Z-Score Term	Leanness	2 (1.67)	0.832
	Eutrophic	72 (60.00)	
	Overweight	27 (22.50)	
	Obesity	12 (10.00)	
	Serious obesity	7 (5.83)	
Z-Score |Preterm	Leanness	0	
	Eutrophic	7 (58.33)	
	Overweight	4 (33.33)	
	Obesity	1 (8.33)%	
	Serious obesity	0	
Abdominal circumference percentile Term	<P50	56 (46.67)	0.028
	P50-P90	44 (36.67)	
	>P90	20 (16.67)	
Abdominal circumference percentile| Preterm	<P50	3 (25.00)	
	P50-P90	9 (75.00)	
	>P90	0	
Average systolic blood pressure percentile | Term	<P50	113 (94.17)	0.619
	P90-P95	3 (2.50)	
	>P95	4 (3.33)	
Average systolic blood pressure percentile | Preterm	<P50	12 (100.00)	
	P90-P95	0	
	>P95	0	
Average diastolic blood pressure percentile | Term	<P50	110 (91.67)	0.374
	P90-P95	2 (1.67)	
	>P95	8 (6.67)	
Average diastolic blood pressure percentile | Preterm	<P50	10 (83.33)	
	P90-P95	1 (8.33)%	
	>P95	1 (8.33)%	
Triglycerides classification | Term	Normal	104 (86.67)	0.177
	Abnormal	16 (13.33)	
Triglycerides classification| Preterm	Normal	12 (100.00)	
	Abnormal	0	
Total cholesterol classification | Term	Normal	110 (91.67)	0.298
	Abnormal	10 (8.33)	
Total cholesterol classification | Preterm	Normal	12 (100.00)	
	Abnormal	0	
Capillary blood glucose (CG) | Term	Normal	45 (37.50)	0.39
	Abnormal	75 (62.50)	
Capillary blood glucose (CG) | Preterm	Normal	3 (25.00)	
	Abnormal	9 (75.55)	

*p-value from the independence chi-squared test (α=0.05).

changes, the schoolchildren were evaluated regarding the other criteria that could show the presence of metabolic changes. Those with the presence of two or more MS criteria in addition to the aforementioned WC change, were indicated as having MS (Table 3).

Of the children with WC changes, 90% had a change in mean systolic BP, being statistically significant ($p < 0.001$). For TG values, despite being statistically significant ($p < 0.001$), only 5% showed values above the reference. PPBG values showed that 65% of the sample was above 100 mg/dL. However, it must be considered that they were not fasting.

Thus, 65% of children with WC changes presented clinical criteria that can be considered as MS markers. Despite this percentage of markers for MS, when analyzing the variables according to Z-score for those classified as overweight and obesity, no statistical association was found between obesity or

Table 3: Presence and absence of clinical criteria that indicate markers for metabolic syndrome in full-term children aged 5 to 9 years with AC > P90. Toledo-PR, Brazil, 2019. (N = 20).

Variables	Categories	n (%)	p-value*
Average systolic blood pressure percentile	Regular Abnormal	2 (10.00) 18 (90.00)	<0.001
Average diastolic blood pressure percentile	Regular Abnormal	20 (100.00) 0 (0.00)	-
Triglycerides (mg/dL)	Regular Abnormal	19 (95.00) 1 (5.00)%	<0.001
Total cholesterol (mg/dL)	Regular Abnormal	20 0 (0.00)	-
Capillary blood glucose (CG mg/dL)	Regular Abnormal	7 (35.00) 13 (65.00)	0.057
Metabolic syndrome classification	No Yes	7 (35.00) 13 (65.00)	0.057

*p-value from the independence chi-squared test (α=0.05).

Table 4: Overweight and obesity associated with variables of lipid, glycemic and blood pressure profiles as per reference standards. Toledo-PR, 2019. (N = 44).

Variables		Overweight	Obese	
	Categories	n (%)	n (%)	*p-value
Triglycerides	Normal	26 (83.87)	10 (76.92)	0.586
	Abnormal	5 (16.13)	3 (23.08)	
Total Cholesterol	Normal	29 (93.55)	11 (84.62)	0.347
	Abnormal	2 (6.45)	2 (15.38)	
Capillary blood glucose	Normal	16 (51.61)	5 (38.46)	0.426
(CG)	Abnormal	15 (48.39)	8 (61.54)	
Average systolic blood pressure percentile	<P90 P90-P95 >P95	29 (93.55) 0 (0.00) 2 (6.45)	12 (92.31) 1 (7.69)% 0 (0.00)	0.094
Average diastolic blood pressure percentile	<P90 P90-P95 >P95	29 (93.55) 0 (0.00) 2 (6.45)	10 (76.92) 2 (15.38) 1 (7.69)%	0.066

*p-value from the independence chi-squared test (α=0.05).

overweight. Variables TG, TC, PPG, systolic and diastolic BP have shown that most subjects with this condition exhibited values considered normal for age (Table 4).

DISCUSSION

The results revealed a significant number of schoolchildren was overweight for their age. It should be noted that the largest proportion of overweight was born prematurely. Besides, in the analysis of students with WC changes, a statistically significant relationship was observed for changes in mean systolic BP. The postprandial glycemic profile was above the reference values, with a higher frequency among those of the GSP group.

The WC is considered as a predictor of cardiovascular risk according to the SBC besides, the relationship between birth weight and central obesity risk was observed among Chinese's children and adolescents [16]. In association with prematurity, it is observed that in a research [17], carried out with 388 children aged 6 and 7 years and born at less than 28 weeks of gestational age (extreme premature), 22% were overweight, and 10% were obese at an early school age. In our study, 9% of the children evaluated were premature. When analyzed separately in two groups (full term and preterm), the presence of overweight and obesity was observed at high rates in both groups, 38.33% in GSFT and 41.66% in GSP, which is consistent with the prediction that obesity and overweight rates have been increasing [1].

Childhood obesity is considered a predictor of insulin resistance, especially among premature infants who have suffered intrauterine restriction and have undergone various treatments and procedures in the neonatal phase, during hospitalization in an intensive care unit [18]. In our study, a significant frequency of premature births, in addition to presenting obesity, also showed a higher percentage of changes in postprandial blood glucose.

The lipid profile assessment demonstrated changes in the reference value for TG in 13.3% of children in the GENT group and 8.3% for TC. The highest serum concentrations of TG and TC were observed in those with overweight and obesity, which suggests the need for interventions related to the practice of physical activity and diet in order to reduce the risk of cardiovascular diseases in adulthood [19].

In the assessment of overweight prevalence and lipid profile of 1224 students, associated with the practice of physical activity and food consumption, 19.3% of them were overweight and dyslipidemia was present in 65.9% in the total sample [20].

Excess weight and changes in the lipid profile are present among schoolchildren, regardless of the family's social condition as a study reference, showed in this group with overweight/obesity there was a higher prevalence of TC and TG [21].

In the present study, of all other variables studied, when classified as Z-score or percentile, the only one showing a statistical difference was WC. Thus, among the 20 children (16% of the total sample), presenting WC above P90 when assessed for other metabolic changes, 65% of them had clinical criteria that can be cogitated as MS markers. WC is considered an independent predictor of cardiovascular risk in adults and, in children, it is an important indicator of insulin resistance, dyslipidemia and arterial hypertension, which are the components of MS. Children with WC > P90 are more prone to multiple risk factors than children with WC below this percentile [22,23]. The use of waist/height ratio is the best predictor of adiposity in children and adolescents for cardiovascular risk, to the detriment of BMI used alone. As a result, the maintenance of WC below half the height is recommended [24].

In the literature, overweight children and adolescents were almost three times more likely to have high blood pressure than their eutrophic counterparts [25]. In the present study, of the total number of children with WC above P90 for their age, 90% of them had mean systolic BP changes. Regarding arterial hypertension, excess body fat is important in the assessment of children and adolescents. In order to prevent Systemic Arterial Hypertension (SAH), the use of BMI associated with at least one other anthropometric method (triceps or WC skinfold thickness) becomes essential. A study that evaluated 4445 children between 8 and 10 years old identified that 14.6% of them were defined as obese according to BMI, among which 3.4% were pre-hypertensive and 2.2%, hypertensive. Among the anthropometric variables measured, WC was the one that obtained the greatest predictive power for SAH occurrence [26].

The identification of children at high risk for MS will facilitate the implementation of appropriate screening programs. This screening should include classification according to BMI and WC, blood pressure, lipid profile, blood glucose and an oral glucose tolerance test, if indicated. It is necessary to interpret each value obtained according to the referenced cut-off points, specific for age, gender and race. Although different guidelines have proposed several treatment approaches for MS during the past decade, there is no specific treatment at this time. However, all of these guidelines converge on the importance of changes in lifestyle, defined by an appropriate nutritional program for the age and with regular physical activity. Even in the absence of weight loss, lifestyle interventions can have positive effects on MS components [7].

Results of this study can be justified by the children's age, since, as they are very young, the body has not yet suffered repercussions in metabolic homeostasis. However, if the chronic condition of obesity persists, these children may have metabolic changes as early as in adolescence.

Due to it is a cross-sectional study, the main restriction was the assessment of children at just a given time. Another limitation to be considered, refers to sample size, which had small number of participants because the logistics used for data collection, mainly for carrying out capillary tests. In addition, the blood glucose collection was not performed on an empty stomach. Thus, results showed the need for further studies in this age group in order to characterize the metabolic, anthropometric and blood pressure profile of students in different regions of the country, thus, contributing to support the health management of this group, aiming to reduce the risk of future chronic conditions.

ACKNOWLEDGMENTS

To the National Council for Scientific and Technological Development - CNPq for assistance (universal call 014/2014, approved by process 452639 / 2010-2).

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Cite this article

Hendges GM, de Mello ED, Bonfleur ML, Viera CS. Anthropometric and Metabolic Profile of Schoolchildren Born Full Term or Preterm: A Cross-Sectional Study. Ann Pediatr Child Health 2021; 9(2): 1224.