Obesity and cardiovascular risk factors in school children from Sorocaba, SP

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Summary

Objective: To verify the prevalence of obesity, systemic arterial hypertension (SAH), waist circumference and *acanthosis nigricans* (AN) in school children from Sorocaba, in 2009 and associate them with risk factors. **Methods:** A probabilistic sample study was carried out with 680 children (7-11 years) from 13 public schools from the city of Sorocaba, SP. A questionnaire containing questions on physical activity, time spent watching television, playing with videogames and computers (TV/VG/PC), student and parental antecedents of arterial hypertension, renal or cardiac disease, and economic level was applied. On physical examination, weight, height, waist circumference (WC) and blood pressure (BP) were measured; presence of AN was observed. The prevalence of nutritional disorders, SAH, WC increase and presence of AN were calculated. To associate body mass index (BMI) $\geq P_{85}$ and BP $\geq P_{90}$ with the other variables, chi-square or Fisher's exact test (significance $p < 0.05$) and crude and adjusted prevalence odds ratio (POR) were used. **Results:** The prevalence of BMI $\geq P_{85}$ was 22.1% [95% CI: 19.0-25.3%], of BP $\geq P_{90}$ 10.9% [95% CI: 8.6-13.5%], increased WC 15.4% [95% CI: 12.9-17.9%] and AN 3.8% [95% CI: 2.6-5.6%]. Paternal antecedents were associated with weight excess in both analysis (POR: 1.76; 95% CI: 1.05-2.95; p = 0.02). High blood pressure was associated with female sex (POR: 1.90; 95% CI: 1.12-3.23; p = 0.01), more time spent with TV/VG/PC (POR: 1.82; 95% CI: 1.00-3.36; p = 0.03), AN (POR: 8.18; 95% CI: 3.37-19.80; p < 0.00), obesity (POR: 4.09; 95% CI: 2.41-6.94; p < 0.00) and WC (POR: 4.83; 95% CI: 2.77-8.41; p < 0.00). After the multivariate analysis, the female sex (adjusted POR = 2.15; 95% CI: 1.17-3.93) and obesity (adjusted POR = 9.51; 95% CI: 4.77-18.97) remained. **Conclusion:** The prevalence of weight excess, SAH, increased WC and AN in these school children was relevant. This fact justifies the use of these measurements.

Keywords: Obesity; hypertension; waist circumference; *acanthosis nigricans*.

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Introduction

Obesity, currently considered a public health problem, is a chronic, multifactorial disease that suffers the influence and interaction of several behavioral, environmental and genetic factors. Complications can occur as early as the pediatric age range, especially cardiovascular and metabolic ones such as *diabetes mellitus* type 2[1].

The body mass index (BMI), although it does not measure the distribution of fat, is the most widely used method in clinical practice for the diagnosis of obesity. The distribution of fat, with a predominance of visceral fat, is related to cardiovascular complications. The waist circumference has been proposed in population studies as an assessment method, including for the pediatric age range[2].

The prevalence of systemic arterial hypertension (SAH) in children has increased, mainly due to its association with obesity. Its presence in an early age range predisposes to its continuation into adulthood. High blood pressure can cause the development of coronary artery disease, stroke, seizures, heart and kidney failure[3].

Acanthosis nigricans (AN) is a skin condition characterized by darkening and thinning of the skin in specific regions, with one of the most important regions being the posterior part of the neck[4]. It is associated with obesity and metabolic alterations such as insulin resistance and *diabetes mellitus*[5-7].

Due to the increasing prevalence of obesity and its complications, the aim of this study was to determine the prevalence and associated risk factors of obesity, hypertension, increased waist circumference and the presence of AN in school children aged 7 to 11 years in the city of Sorocaba – SP, in 2009.

Methods

This was a cross-sectional, descriptive and analytic study of a random sample of 680 students from municipal schools in the city of Sorocaba (São Paulo), carried out in 2009. At that time, Sorocaba had approximately 610,000 inhabitants, of which 42,278 were school children attending 1st to 4th grades of elementary school. From these 23,000 were enrolled in 37 public schools[8].

To determine the size of the sample, we took into account an estimated prevalence of overweight and obesity in a community of 20.0%[1], $\alpha = 5\%$ and an absolute precision of 3%, resulting in 680 subjects[9].

The selection of individuals occurred in two stages: first, the schools were identified and randomly selected by region according to geographic division and sector classification of income distribution adopted by the Department of Housing, Urbanism and Environment of Sorocaba: Northeast (NE), North (N), Northwest (NO), West (W), south (S) and East (E). In the second stage, 680 children were selected by probabilistic sampling in the previously determined 13 schools.

The Free and Informed Consent Form (FICF) and a questionnaire were sent to randomly selected students, and those who did not fill them out after 3 attempts or who missed the day of the clinical examination were excluded and replaced by previously selected alternatives.

The school children were submitted to clinical examination after consent was given by parents (or tutors) and after the latter answered the questionnaires. Examinations were performed by the study researcher, previously trained in the school premises so as not to disturb the students' routines. We excluded children younger than seven years and older than 11 years, the ones in whom it was impossible to perform measurements and girls with a history of menarche.

The evaluation of the history of personal or family risk was carried out by means of a questionnaire, which asked about the presence of hypertension, kidney and heart disease in children and parents separately, and considered as positive the presence of at least one affirmative answer to any one of the three items. Participants were also asked about the practice of physical activity, daily time in hours spent watching television (TV), playing video games (VG) or in front of the computer (PC). The economic classification was made according to the criteria of the Brazilian Association of Research Companies (ABEP), which uses a score system for possession of items and level of education of the household head, ranging from A to E[10].

The regions were regrouped into S-E-NE and W-N-NW, with the first representing the lowest poverty rate; and the economic classification was established as AB, C and DE due to the small number of students in the extreme categories. The time spent with the TV, PC and VG was classified as more or less than two hours per day[11].

The clinical examination included measurements of weight, height and waist circumference[12] and two blood pressure (BP) measurements using a mercury column portable device – PLUS 005, UNITEC, at the beginning and the end of examination, with an interval of two to three minutes between measurements. The BP measurement was taken in the right arm with the child sitting at rest, using cuffs of appropriate sizes. The employed method was the auscultatory one, with the systolic and diastolic pressures corresponding to Korotkoff phases I and V[13]. The mean BP was obtained with the two BP measurements. AN was investigated in the posterior region of the neck and considered present or absent[4].

BMI was calculated based on the measured weight and height and nutritional status was classified according to WHO, considering as overweight a BMI between the 85th (P_{85}) and 95th (P_{95}) percentile and as obesity a BMI $\geq P_{95}$, according to the CDC[14]. For waist circumference (WC) z scores were obtained according to age and sex, considering increased when z score was > 2[15].

BP was analyzed according to age, sex and height, being considered normal if systolic BP (SBP) and diastolic BP (DBP) were < 90th percentile (P_{90}). Prehypertension was defined when SBP and/or DBP were ≥ P_{90} and < P_{95} or ≥ 120 × 80 mmHg and hypertension when SBP or DBP were ≥ P_{95}[13].

The prevalence of overweight, obesity, prehypertension and hypertension was determined. Students with overweight and obesity were grouped together and called "excess weight" (BMI ≥ P_{85}), as well as those with prehypertension and hypertension, called "high BP" (BP ≥ P_{90}), as they were at-risk groups.

To evaluate the association of BMI ≥ P_{85} and BP ≥ P_{90} with gender, age group, region, socioeconomic level, personal, paternal and maternal history, physical activity and time spent with TV/VG/PC, we used the chi-square or Fisher's exact test. We also assessed the association between BP ≥ P_{90} with the presence of AN, nutritional status and waist circumference. The crude prevalence odds ratio (POR) was carried out using EpiInfo version 6.04b. The adjusted POR was determined by multivariate logistic regression, using the forward stepwise method (Wald) with the SPSS software, version 16.0 (SPSS Inc., Chicago, IL, USA) and all the variables that in the bivariate analysis showed p < 0.20 were selected for inclusion in the model.

The study was approved by the Ethics Committee of the Faculdade de Ciências Médicas of Universidade Estadual de Campinas on September 23, 2008, with protocol # 737/2008 (CAAE: 3176.0.000.146-08).

Results

Of the 680 students enrolled in the study aged 7 to 11 years, 347 (51.0%) were females, 304 (44.7%) came from the South, East and Northeast regions, 376 (55.3%) came from the West, North and Northwest regions. As for the economic classification, 166 (25.8%) were classes A and B, 376 (58.4%) class C and 102 (15.8%) were classes D and E (Table 1).

Only 171 (27.1%) answered that they practiced physical activity. The mean daily time devoted to activities with TV/VG/PC was 3.5 hours, and 226 (35.0%) of them reported fewer than 2 hours. The presence of personal history was 3.1% among students, 16.1% among the fathers and 17.8% among the mothers (Table 2).

The prevalence of obesity was 9.0% [95% CI: 6.9-11.4%] and 13.1% of overweight [95% CI: 10.6-15.9%]. When we consider the prevalence of excess weight, it was 22.1% [95% CI: 19.0-25.4] (Table 2).

An association was observed in the group with BMI ≥ P_{85} only with the presence of paternal history (POR = 1.76, 95% CI: 1.05-2.95, p = 0.02) (Table 3). For the multivariate analysis, the variables considered were: paternal history (p = 0.02), region (p = 0.19), time spent with television, computer or video game (p = 0.13) and socioeconomic level (p category DE = 0.14). Only the paternal history remained in the model (POR adjusted = 1.89, 95% CI: 1.11-3.23).

Table 1 – Distribution regarding sex, age, region and socioeconomic status

	n	%
Sex		
Male	333	49.0
Female	347	51.0
Age (years)		
7 ⊢ 8	130	19.1
8 ⊢ 9	160	23.5
9 ⊢ 10	137	20.1
10 ⊢ 11	190	27.9
11 ⊢ 12	63	9.3
Region		
S L NE	304	44.7
O N NW	376	55.3
Socioeconomic status		
A B	166	25.8
C	376	58.4
D E	102	15.8

Regions: S, south; E, east; NE, northeast; W, west; N, north; NW, northwest.

The z score of waist measurement was > 2 in 15.4% of the cases, being 94.3% of them in the excess weight group. AN was observed in 26 (3.8%) patients, 24 (92.3%) of whom had excess weight (Table 2).

The prevalence of arterial hypertension was 5.3% [95% CI: 3.7-7.3%] and prehypertension was 5.6% [95% CI: 4.0-7.6%]. Considering the group with high blood pressure, the prevalence was 10.9% [95% CI: 8.7-13.5%] (Table 2).

With BP ≥ P_{90}, there was an association with the female sex (POR = 1.90, 95% CI: 1.12-3.23, p = 0.01), with time spent with TV, PC or VG for more than 2 hours per day (POR = 1.82, 95% CI: 1.00-3.36, p = 0.03), presence of AN (POR = 8.18, 95% CI: 3.37-19.80, p < 0.00), obesity (POR = 4.09, 95% CI: 2.41-6.94, p < 0.00) and waist z score > 2 (POR = 4.83, 95% CI: 2.77-8.41, p < 0.00) (Table 4). After the multivariate analysis, sex and obesity remained in the model. The risk is 2.15-fold higher for females (POR adjusted = 2.15, 95% CI: 1.17-3.93) and 9.51-fold higher in the obese (POR adjusted = 9.51, 95% CI: 4.77–18.97).

Discussion

Sorocaba (SP) has good levels of urban development, in parallel with the disordered growth of the peripheral regions[8]. Therefore, changes in lifestyle, including eating and activity habits may be responsible for the high prevalence of excess weight (22.1%), increased waist circumference (15.4%), high BP (10.9%) and presence of AN (3.8%). Students with these alterations were notified through the school by the researcher to seek proper medical guidance.

Table 2 – Alterations in nutritional status, pressure levels and risk factors

	Yes			Total	
	n	%	95% CI	n	%
Overweight	89	13.08	10.64-15.85	680	100
Obesity	61	8.97	6.93-11.37	680	100
BMI ≥ 85th percentile	150	22.05	18.99-25.36	680	100
Pre-hypertension*	38	5.58	3.98-7.58	680	100
Arterial hypertension	36	5.29	3.73-7.25	680	100
BP ≥ 90th percentile	74	10.88	8.65-13.46	680	100
Waist > 2 z scores	105	15.40	12.94-17.94	680	100
Acanthosis nigricans	26	3.82	2.56-5.62	680	100
Personal antecedents	20	3.06	1.88-4.69	652	100
Paternal antecedents	94	16.12	13.23-19.36	583	100
Maternal antecedents	113	17.82	14.96-21.07	634	100
Physical activity	171	27.14	23.70-30.79	630	100
TV/VG/PC ≤ 2 hours	226	35.00	31.35-38.86	645	100

BMI, body mass index; CI, confidence interval; TV/VG/PC, time spent with television/videogame/computer; *pre-hypertensive and hypertensive patients.

Table 3 – Prevalence odds ratio in children with BMI ≥ 85th percentile

	BMI ≥ 85th percentile	BMI < 85th percentile	POR	95% CI	p
Sex					
Male	72	261	0.95	0.65-1.39	0.78*
Female	78	269	1		
Age					
7⊢8	27	103	1		
8⊢9	34	126	1.03	0.56-1.89	0.92*
9⊢10	37	100	1.41	0.77-2.59	0.23*
10⊢11	41	149	1.05	0.59-1.88	0.86*
11⊢12	11	52	0.81	0.34-1.86	0.58*
Region					
S L NE	74	230	1		
O N NW	76	300	0.79	0.54-1.15	0.19*
Socioeconomic status					
A B	42	124	1		
C	80	296	0.80	0.51-1.25	0.30*
D E	18	84	0.63	0.33-1.22	0.14*
Personal antecedents					
Yes	4	16	0.85	0.24-2.75	0.51**
No	144	488	1		
Paternal antecedents					
Yes	29	65	1.76	1.05-2.95	0.02*
No	99	390	1		
Maternal antecedents					
Yes	29	84	1.26	0.77-2.07	0.33*
No	112	409	1		
Physical activity					
Yes	36	135	1		
No	109	350	1.17	0.75-1.83	0.47*
TV/VG/PC					
≤ 2h	43	183	1		
> 2h	101	318	0.74	0.49-1.12	0.13*

BMI, body mass index; POR, crude prevalence odds ratio; CI, confidence interval; p, statistical significance; Regions: S, south; E, east; NE, northeast; W, west; N, north; NW, northwest; TV/VG/PC, time spent with television/videogame/computer; *Chi-square test; **Fisher's exact test.

Table 4 – Prevalence odds ratio in children with BP ≥ 90th percentile

	BP ≥ 90th percentile	BP < 90th percentile	POR	95% CI	p
Sex					
Male	26	307	1		
Female	48	299	1.90	1.12-3.23	0.01*
Age					
7 ⊢ 8	15	115	1		
8 ⊢ 9	16	144	0.85	0.38-1.91	0.67*
9 ⊢ 10	18	119	1.16	0.53-2.56	0.69*
10 ⊢ 11	18	172	0.80	0.37-1.76	0.55*
11 ⊢ 12	7	56	0.96	0.33-2.69	0.93*
Region					
S L NE	32	272	1		
O N NW	42	334	1.07	0.64-1.79	0.78*
Socioeconomic status					
A B	20	146	1		
C	45	331	0.99	0.55-1.81	0.97*
D E	7	95	0.54	0.20-1.41	0.17*
Personal antecedents					
Yes	0	20			
No	72	560			
Paternal antecedents					
Yes	13	81	1.35	0.67-2.69	0.36*
No	52	437	1		
Maternal antecedents					
Yes	13	100	0.93	0.47-1.85	0.81*
No	56	465	1		
Physical activity					
Yes	18	153	1		
No	51	408	1.06	0.58-1.95	0.83*
TV/VG/PC					
≤ 2 hours	17	209	1		
> 2 hours	54	365	1.82	1.00-3.36	0.03*
Nutritional status					
BMI < P_{85}	38	492	1		
BMI ≥ P_{85}	36	114	4.09	2.41-6.94	0.00*
Waist circumference					
z escore ≤ 2	44	531	1		
z escore > 2	30	75	4.83	2.77-8.41	0.00*
Acanthosis nigricans					
Yes	12	14	8.18	3.37-19.80	0.00**
No	62	592	1		

BMI, body mass index; POR, crude prevalence odds ratio; CI, confidence interval; p, statistical significance; regions: S, south; E, east; NE, northeast; W, west; N, north; NW, northwest; TV/VG/PC, time spent with television/videogame/computer; * Chi-square test; ** Fisher's exact test.

According to the WHO classification and considering the CDC 2000 curve, public school students aged 7 to 11 years, had respectively 13.1 and 9.0% of overweight and obesity, results similar to those of Martin et al.[16], who obtained an average of 12.2 and 10.1% of overweight and obesity, respectively, in school children of Sorocaba in 2006. This is a slightly lower prevalence than the one observed in Brazil, where a significant increase in overweight (34.8% in boys and 32.0% in girls) and obesity (16.6% in boys and 11.8 % in girls) has been observed in children between 5 and 9 years of age[17].

Studies on the prevalence of obesity in other countries have shown 16.8% and 3.6% of overweight and obesity, respectively, in Germany[18] and 20% and 6% respectively in Northern Italy[19]. In the U.S., rates are higher, as demonstrated by a study carried out between 2007-2008, which showed 14.5% of BMI > P_{97}, 19.6% > P_{95} and 35.5% > P_{85} in children aged 6 to 11 years[20].

This study showed no association between obesity and gender, as in the study by Nagel et al.[18]. A national study in children showed a higher prevalence of overweight and obesity in boys; in adults, the prevalence rates were similar in both genders, with an upward trend for the male sex and stability for the female sex[17]. A North-American study of the increasing trend of obesity has shown that girls in the 80s-90s had a higher prevalence than boys, with no changes in the last decade, and that the prevalence in boys has increased, especially above the P_{97}, equaling that of girls. The study suggests that for the next years the prevalence of obesity tends to remain; however, with an increasing trend for more severe cases[20].

Changes in diet, lifestyle habits and urbanization, which may be a reflection of socioeconomic level, have led to an "obesogenic" environment[1]. It is believed that at the same time, the social and economic pattern can distinctly influence different populations[21]. This study observed no association between socioeconomic status and place of residence as found by Martins et al.[16], who observed more children with excess weight in the regions of Sorocaba with lower poverty rates. Nagel et al.[18] also showed the influence of migration and socioeconomic status on excess weight, probably due to cultural differences and living standards.

Among the daily habits, the decrease in physical activity has been observed in parallel to longer periods spent watching TV or playing video games or using a computer, as variables related to weight gain. This study grouped the three activities (TV, video games and computer); however, the importance of each one of them, separately, is undisputable and it is believed that watching TV has a greater influence on weight gain by being more frequent in the population and due to the influence of the media, which very often advertises calorie foods and drinks[22].

The practice of physical activity (27.1%) and spending more than two hours a day watching TV, playing videogames and computer games (65%) were not associated with excess weight, probably due to the high mean time (3.5 hours/day) dedicated to sedentary activities. These findings differ from those observed in the Brazilian study by Wells et al.[23] and in studies carried out in other countries[18,24], when only the time spent watching TV was accounted for.

The presence of paternal history of kidney disease, heart failure or hypertension was a factor associated with obesity among students. Knowing that this association occurs in adults with a history of obesity, this finding reinforces what was observed by Wardle et al.[25], showing that increased adiposity, assessed by the waist circumference and BMI in childhood and adolescence, has been related mainly to genetic factors, after the obesity epidemics.

Regarding the WC, it was observed that the vast majority of students with WC measurements > 2 z scores were among those with excess weight, similar to what was found in other studies. The waist measurement evaluates the distribution of fat in relation to the presence of visceral fat, and is indicated for population studies as it is easy to obtain and a low-cost procedure, when compared to the gold standard, MRI, CT or dual-emission X-ray absorptiometry (DXA)[2,15]. One of the difficulties of its use is the comparison with reference curves, as so far, there is no international standard, and significant ethnic differences have been observed[15].

The presence of visceral fat is related to cardiovascular problems in adults, with few studies having been carried out with children. Recent studies have shown association with increased BP[2,3] and better risk association when compared to BMI[26,27].

The prevalence of prehypertension (5.6%) and SAH (5.3%) was different from that reported by the Brazilian Society of Hypertension in children and adolescents, which is 2% and 13%, respectively[28]. However, it was similar to the results obtained by Genovesi et al.[19] in a cross-sectional study of 5,131 children aged 5-11 years from northern Italy, which showed 2.7 and 3.4% of prehypertension and hypertension, respectively. However, a study with high school students (14-20 years) in Recife, state of Pernambuco, Brazil, showed a higher prevalence (17.3%) of hypertension[29]. A U.S. population study showed a SAH trend in children from 1988-94 to 1999-2002, from 7.7% to 10.0% in the prehypertensive and 2.7% to 3.7% in hypertensive patients, mainly related to weight gain and increased WC[30].

Between genders, hypertension was more prevalent in females (POR adjusted = 2.15, 95% CI: 1.17-3.93), as opposed to other studies which showed a predominance of males[29-31] and others that showed no differences between the sexes[32].

The association between hypertension and obesity observed in the study (POR adjusted = 9.51, 95% CI: 4.77-18.97) has been described in several national studies and in other countries[3,29-32]. In Mexico, a high prevalence (22.8%) of hypertension was obtained, associated mainly to abdominal circumference and obesity and unrelated to physical activity and time spent with TV and videogames[3]. Beck et al.[31], in a cross-sectional study, found an association between WC and SAH in Brazilian adolescents, and suggested the evaluation of this anthropometric parameter as a measure of predisposition to blood pressure increase.

AN was observed in small numbers of children (3.8%). AN prevalence of 19.4% was observed in the U.S. population between 7 and 65 years, which showed a higher risk for diabetes[7]. A recent study in American individuals of varied ethnicity aged 7-17 years, with 32% of obesity, observed the presence of AN in 4% of Caucasians, 19% of African-Americans and 23% of Hispanics[5].

This skin alteration, at lower prevalence in this study, should be taken into consideration due to the lower age range studied and the lower prevalence of obesity in this population. Regarding this parameter, it should be emphasized that it is easy to be verified and its high association with obesity and metabolic disorders such as insulin resistance and diabetes[5-7].

The present study has two limitations. The questionnaire answered by the parents or tutors lacked information on some variables, which can lead to data interpretation difficulties. In relation to blood pressure, even through the recommended techniques were used, as well as the mean of two measurements obtained on the same day, there may have been an increase in the number of children with high blood pressure. However, these findings are important for screening and posterior follow-up, as sequential measurements would be needed for the diagnosis.

Conclusion

In this study, the high prevalence of obesity and overweight and the lack of association with the studied factors make it difficult to identify at-risk students. This diagnosis is crucial in this age group, because studies show trends in which the prevalence of children with overweight and obesity has remained steady, being worse in those who already have the problem[17,20].

Concerning SAH, the high number of school children with high BP and the fact that it is associated with excess weight reinforce the importance of measuring it in all children, as previously recommended[13]. Waist measurement and verification of *acanthosis nigricans* can be included in pediatric evaluations. Therefore, preventive measures such as the early diagnosis of overweight and its complications, nutritional guidelines and healthy lifestyle habits should be adopted for all children.

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