Obesity and arterial hypertension in schoolchildren from Santa Cruz do Sul – RS, Brazil

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Summary

Objective: To verify the prevalence of obesity and hypertension in schoolchildren from Santa Cruz do Sul – RS, Brazil, in 2005 and 2008. **Method:** The study was performed with two consecutive cross-sectional measurements, consisting of a stratified cluster sample, totaling 414 students, aged between 7 and 17 years, of which 215 (51.9%) were males and 199 (48.1%) were females. Obesity was assessed by body mass index (BMI) and percentage of body fat (%BF). Hypertension was measured by blood pressure values, both systolic (SBP) and diastolic (DBP). **Results:** BMI assessment showed 18.6% and 22.3% of excess weight in males and 22.6% and 14.6% in females (in 2005 and 2008, respectively). Regarding obesity, the prevalence was 4.7% in both years for males and a reduction from 12.6% to 9.0% was observed in females. When analyzing the difference between assessments, there was significance in the BMI classification ($p = 0.022$) and %BF ($p = 0.017$) only in females. Statistically significant changes in SBP were found only in males ($p < 0.001$). **Conclusion:** The levels of excess weight, obesity, and %BF in females, as well as the increased levels of systolic blood pressure in males, demonstrate the need for early intervention through more effective public health campaigns.

Keywords: Obesity; hypertension; public health; child; teenager.

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Introduction

Lifestyle changes have occurred according to social preferences throughout human evolution, and population characteristics change accordingly. In this sense, in the past two centuries there was a phenomenon the literature called epidemiological transition, in which non-transmissible chronic diseases have gained focus, while infectious and parasitic diseases are no longer the main morbimortality agents[1].

Non-transmissible chronic diseases are those that have multiple etiologies with a prolonged course, which occur together with comorbidities, and are often asymptomatic for long periods. Most of them have modifiable risk factors in their genesis[1], of which obesity is one of the most important, as it generates systemic alterations, mainly cardiovascular and endocrine effects[2].

Cardiovascular diseases are considered a significant public health problem, justified by the fact that they are the leading cause of death and disability in developed and developing countries[3]. Among the wide range of cardiovascular diseases, one of the most prevalent in the population is systemic arterial hypertension, which is characterized by high and sustained levels of blood pressure (BP)[4]. It is known that hypertension is no longer observed only in adults. Previous studies have shown that obese children and adolescents have the potential to develop this disease[2,5].

Within this context, the childhood environment appears to be strongly related to the risk of non-transmissible diseases in adulthood. Stimulus during the child's development results in permanent adaptation responses that produce long-term changes in tissue structure or function[6]. Cardiovascular diseases are closely related with genetics, and when associated with risk factors generated by an inappropriate lifestyle early in life, they result in diseases later manifested in adults[7]. Finally, early intervention is necessary, as it alone is capable of ensuring a healthy lifestyle for the cardiovascular system in adulthood, thus modifying the high rates of cardiovascular morbidity and mortality[8].

In this sense, the present study aimed to determine the prevalence of obesity and hypertension among schoolchildren in Santa Cruz do Sul, Rio Grande do Sul, in the years 2005 and 2008.

Methods

This was a study with two consecutive cross-sectional measurements (before-and-after) with children and adolescents enrolled in schools in the city of Santa Cruz do Sul – RS, Brazil. This research is a sub-sample of the "Lifestyle, somatomotor, and risk factors profiles: a study of schoolchildren in Santa Cruz do Sul and participants in the UNISC" and "Health and lifestyle in school and family: health indicators in schoolchildren and their association with family health in urban and rural areas of Santa Cruz do Sul" projects, both from the Universidade de Santa Cruz do Sul.

The sample consisted of the 414 schoolchildren assessed in 2005 that were measured again in 2008, thus constituting, for this study, a closed cohort. The data originally collected in the years 2005 and 2008 were randomly selected from a stratified cluster sample (center, and north, south, east, and west regions of the outskirts of the urban area, and north, south, east, and west rural regions), from 18 schools (public and private), 14 from the urban area and four from the rural area.

The study included all students enrolled in the school aged 7 to 17 years, who were selected by drawing lots, after the informed consent had been signed by a parent or guardian, authorizing the student's participation in the assessments and tests. The study excluded all children with any type of disabling disease that would prevent testing.

In this study, the variables were: body mass index (BMI), percentage of body fat (%BF), systolic (SBP) and diastolic (DBP) blood pressure, as well as the classifications of these variables, with BMI as a continuous variable classified into three categories (normal, overweight, and obesity), and the presence of hypertension (defined by the VI Brazilian guidelines on hypertension, 2010)[4]. Their distributions were analyzed by gender and year of sample for discrimination purposes.

BMI was calculated using the formula: weight (kg) ÷ height (m)^2, and was categorized according to the percentile curves for gender and age, following the protocol by Conde and Monteiro[9], intended for the assessment of nutritional status of Brazilian children and adolescents. To evaluate the sum of skinfolds (ΣSF) and %BF, triceps and subscapular folds were measured with a Lange compass (Multimed, Skinfold Caliper – USA). To calculate the %BF, the Slaughter equation was used[10], being subsequently classified according to the data provided by Heyward and Stolarczyv[10].

Blood pressure was measured with the student sitting at rest. A sphygmomanometer (BD®, aneroid – Germany) and a stethoscope (Premium, Rappaport – China) were used on the right arm with an appropriate-size cuff for the arm circumference. Pressure was classified by the 90th and 95th percentiles for the borderline and hypertension ranges, respectively, according to the parameters of the Brazilian Society of Hypertension[4]. This study did not consider the 99th percentile for hypertension stratification. Thus, the 95th and 99th percentiles were unified, classifying the students in both ranges as 'hypertensive'. The evaluating team was qualified for the assessments.

The Statistical Package for Social Sciences for Windows (SPSS – version 18.0) was used for data analysis. Descriptive statistics comprised measures of central tendency and dispersion, frequency, and percentage. The Kolmogorov-Smirnov test was used, and showed normal distribution for all continuous variables, which allowed for the use of parametric tests. Thus, the difference between the groups (2005 and 2008) was calculated using the Chi-squared test for trends in categorical variables; Student's *t*-test was used for numeric variables. In order to analyze the relationship between anthropometric variables and blood pressure, Pearson's linear correlation was used. The level of significance was set at $p < 0.05$.

The project was previously submitted and approved by the Ethics Committee on Human Research at Universidade de Santa Cruz do Sul (UNISC), under protocol No. 2780/10, in accordance with the Declaration of Helsinki. Parents or guardians signed the informed consent form prior to enrollment in the study, which allowed the participation of their children in assessments and tests. Students who did not participate in the two evaluations were excluded.

Results

A total of 414 students were evaluated in 2005 and reassessed in 2008; these were students from public and private schools in the city of Santa Cruz do Sul, Rio Grande do Sul, Brazil. The overall mean age was 9.8 (SD 1.8 years) and 14.0 (SD 1.8 years), respectively in 2005 and 2008. Regarding gender, there were 215 (51.9%) males and 199 females (48.1%).

Table 1 shows the total mean as well as the differentiated means by gender for BMI and %BF; there was an increase in both variables. It should be noted that the overall mean BMI significantly increased ($p < 0.001$) from 17.88 (SD 3.26) kg/m² to 20.15 (SD 3.74) kg/m² in males, and from 18.29 (SD 3.47) kg/m² to 20.73 (SD 4.09) kg/m² in females ($p < 0.001$).

Table 2 shows that there were different results regarding gender. For males, there were no statistically significant changes between the two years regarding both the BMI classification and %BF. In females, there was a statistically significant difference regarding BMI ($p = 0.022$) and %BF ($p = 0.017$). Moreover a reduction in BMI classification, but an increase of %BF was observed in females.

Table 2 shows that there were statistically significant changes in the classification of SBP only in males ($p < 0.001$) when the difference between the two years was assessed. Regarding the normal range of SBP, there was a decrease in both genders (of 21% and 10%, respectively, for males and females), while there was an increase of over 10% of both genders in the borderline range.

Although there was no statistical significance in the classification of SBP, a decrease in the number of students in the normal range and an increase in the borderline and hypertension ranges was observed for males and females.

Evaluating possible associations between the dependent variables (SBP and DBP) and independent variables (BMI and %BF), a significant correlation was observed among all of them ($p < 0.05$). For SBP, there was a weak correlation with BMI in both years and with %BF only in 2005. As for DBP, only a weak correlation with BMI was observed in both years (Table 3).

Discussion

The study has demonstrated an increased prevalence of hypertension and borderline BP levels among schoolchildren in Santa Cruz do Sul, aged 7 to 17 years over a period of three years – from 2005 to 2008, which was statistically significant for males.

Another important finding was a significant increase in mean BMI, SBP, and DBP in both genders, and %BF only in females. Regarding the classification, there was a statistically significant decrease in BMI and increase in %BF in females.

Table 1 – Anthropometric parameters

Variable	Year	Male (n = 215) $\bar{x}$ (SD)	p	Female (n = 199) $\bar{x}$ (SD)	p	Total (n = 414) $\bar{x}$ (SD)	p
BMI	2005	17.88 (3.26)	< 0.001*	18.29 (3.47)	< 0.001*	18.08 (3.36)	< 0.001*
	2008	20.15 (3.74)		20.73 (4.09)		20.43 (3.92)	
% BF	2005	19.10 (8.40)	0.649	22.98 (7.77)	< 0.001*	20.96 (8.32)	0.066
	2008	18.72 (8.84)		25.65 (6.94)		22.05 (8.69)	

$\bar{x}$ (SD), mean (standard deviation); BMI, body mass index; %BF, percentage of body fat. *Significant values for $p < 0.05$.

Table 2 – Classification of BMI,% BF, SBP, and DBP comparing the prevalence related to the year and by gender

Variables	Male			Female		
	2005 n (%)	2008 n (%)	p	2005 n (%)	2008 n (%)	p
BMI classification						
Normal	165 (76.8)	157 (73.0)		129 (64.8)	152 (76.4)	
Overweight	40 (18.6)	48 (22.3)	0.540	45 (22.6)	29 (14.6)	0.022*
Obesity	10 (4.7)	10 (4.7)		25 (12.6)	18 (9.0)	
% BF classification						
Low	30 (14.0)	31 (14.4)		25 (12.6)	6 (3.0)	
Optimal	114 (53.0)	109 (50.7)		96 (48.2)	89 (44.7)	
Moderately high	32 (14.9)	36 (16.7)	0.863	39 (19.6)	55 (27.6)	0.017*
High	17 (7.9)	23 (10.7)		19 (9.5)	31 (15.6)	
Very high	22 (10.2)	16 (7.4)		20 (10.1)	18 (9.0)	
SBP classification						
Normal	196 (91.2)	151 (70.2)		174 (87.4)	154 (77.4)	
Borderline	13 (6.0)	35 (16.3)	< 0.001*	10 (5.0)	34 (17.1)	0.180
Hypertension	6 (2.8)	29 (13.5)		15 (7.5)	11 (5.5)	
DBP classification						
Normal	196 (91.2)	182 (84.7)		180 (90.5)	165 (82.9)	
Borderline	11 (5.1)	20 (9.3)	0.076	8 (4.0)	18 (9.0)	0.081
Hypertension	8 (3.7)	13 (6.0)		11 (5.5)	16 (8.0)	

BMI, body mass index; % BF, percentage of body fat; SBP, systolic blood pressure; DBP, diastolic blood pressure; p, chi-squared for trend.
*Values considered significant when p < 0.05.

Table 3 – Correlation of SBP and DBP with BMI and %BF

	BMI		% BF	
	2005	2008	2005	2008
SBP				
r	0.456*	0.446*	0.359*	0.261
p	< 0.001	< 0.001	< 0.001	< 0.001
DBP				
r	0.331*	0.358*	0.258	0.238
p	< 0.001	< 0.001	< 0.001	< 0.001

r, Pearson's correlation; p, level of significance (p < 0.05);
SBP, systolic blood pressure; DBP, diastolic blood pressure;
BMI, body mass index; %BF, percentage of body fat.
*Weak correlation (r = 0.30 to r = 0.49).

The definitions of overweight and obesity, as well as their classification in children and adolescents, show a lot of variability in classification methods, making it difficult to compare results with previous studies[11].

Regarding BMI, the present results demonstrate that there was an increase in the means when compared between the years in both genders. Gupta et al.[12] found similar results in India, showing an increase in mean BMI in males (p = 0.006), also compared with a three-year interval.

Regarding the BMI classification, the schoolchildren had a rate of overweight of 18.6% and 22.3% in males (2005 and 2008, respectively), whereas in females, it was 22.6% in 2005 and 14.6% in 2008. Costa, Cintra and Fisberg[11], in a study in the city of Santos – São Paulo, found lower rates of overweight, but higher rates of obesity, both for males and females. In addition, the authors found greater significance in relation to prevalence of overweight in females, and of obesity, in males; therefore, these results differ from the present study.

In Pelotas – RS[13], the authors found similar values in relation to overweight and obesity for boys (21.3% and 5.1% respectively). For females, 20.5% were overweight and 4.8% obese; the latter were lower than the results found in this study. In Maceió, the overall prevalence of overweight was 9.3%, and 4.5% for obesity, which are lower rates when compared to the present study[14].

Still regarding the BMI classification, a decrease in the normal rates, an increase in overweight, and no alterations in obesity were observed in males. In females, an increase was observed in the normal rate, and a decrease in overweight and obesity. A study in Delhi (India), which assessed schoolchildren in two periods (2006 and 2009), showed a significant increase in the

prevalence of overweight (23.2% to 25.9%, p = 0.023) and obesity (8.9 % to 11.5%, p = 0.002) in boys. In girls, the prevalence of overweight decreased (25.9% to 24.0%, p = 0.227), corroborating the present findings[12].

Regarding the %BF, the main results showing increased and undesirable levels were observed in females, with statistical significance for both means (p <0.001) and classification (p = 0.017). These findings are confirmed by Kolle et al.[15], Morales et al.[16], Bergmann et al.[17], and Alvarez et al.[18]. McCarthy[19] reports that there are known differences in the development of adiposity between males and females. The figures are similar for both genders until puberty, diverging sharply from this period onward, in which the males proportionally decrease %BF in relation to females.

The fact that females have shown a decrease in overweight and obesity rates as demonstrated by BMI, as well as an undesirable increase in %BF, can be explained by the hormonal transition that occurs during puberty, in which body fat development stimulation occurs by estrogen action in girls, increasing the accumulation of body fat and decreasing muscle mass ratio. The higher content of fat tissue occurs through both the larger amount of tissue and the greater size of adipocytes[20]. Furthermore, BMI is an index that does not reflect body composition[21].

Kaplowitz[22] reports that several recent studies have shown that females with a relatively higher body mass index are more likely to have an early menarche, suggesting a relationship between hormonal status and body composition.

In another scenario, Rivera et al.[23] found, in the city of Maceió, a prevalence of sedentary lifestyle of 93.5% among the assessed children and adolescents, being more common in female adolescents. In this study, individuals were considered sedentary if they did not exercise at moderate to high intensity during the week.

Regarding blood pressure, significant values were observed in relation to the classification of systolic blood pressure in males (p < 0.001). Despite that, a decrease was noticed in the number of children and adolescents in the normal BP range, and an increase in the borderline and hypertension ranges for SBP and DBP in males and in DBP for females. For SBP, there was a decrease in the hypertension range among girls, considering the last cutoff studied. This fact may be related to the aforementioned hormonal factors of puberty, as the estrogen has a cardioprotective effect, including effects on the arterial wall[24,25], which hypothetically could justify the decreased levels of systolic hypertension in girls. In addition to hormonal factors, the practice of physical activity, which was not assessed in this study, may influence the decrease in blood pressure[26].

Regarding means, a significant increase (p <0.001) was observed for SBP and DBP between the years for both genders. However, this increase is expected, as the study assessed the same schoolchildren, and they grew during this period. In this sense, it is worth emphasizing the close relationship between height and blood pressure.

Steinthorsdotti et al.[27], in a study of Icelandic children aged 9 to 10 years, found a prevalence of higher blood pressure in boys (13.9% *versus* 12.3%). Similar findings on BP increase were found by Bancalari et al.[28] in Chile, Salvadori et al.[2] in Canada, Sorof et al.[29] and Morrison et al.[30] in the US, Aguirre et al.[31] in Spain, Benmohammed et al.[32] in Algeria, and Gomes and Alves[33] and Araújo et al.[34] in Brazil.

Thus, national and international studies have demonstrated a higher prevalence of hypertension in males. Despite this fact, an explanation on gender difference regarding alterations in systolic blood pressure was not found in the literature[2,28-35].

Although the mechanisms by which SBP alterations occur more often in males are not yet known, it is important to identify hypertension in childhood and adolescence for both genders, considering that, as reported by Liang Mi[36], 50% of children with hypertension become hypertensive adults, and among the hypertensive prepubertal individuals, 34.3% developed this alteration as adults.

When correlating blood pressure variables, both systolic and diastolic, with anthropometric variables assessed in this study, a weak correlation was found between the following variables: SBP and BMI (in 2005 and 2008), SBP and %BF (only in 2005), and DBP and BMI (in 2005 and 2008). For all variables analyzed in this correlation, a p < 0.001 was obtained. Steinthorsdotti et al.[27] found a significant correlation between BMI and SBP (r = 0.038, p <0.001). Although the present study did not evaluate waist circumference, the data have been analyzed by this group in another study, showing a moderate correlation between this variable and systolic blood pressure (r = 0.498 and p < 0.001)[37].

The authors believe that there are factors, which were not the object of this study, that can influence the results, such as the daily habits of using the computer, watching TV, or playing video games for many hours[38,39]; the number of BP measurements[40]; the school environment[41]; dietary habits; and socioeconomic class[38].

Regarding blood pressure levels, the differences in prevalence in relation to other studies, which can be attributed to differences in ethnicity, local economy, and the parameters used to establish pressure levels for each study, must be considered[40]. In Belo Horizonte, a study by Garcia et al.[42] found that SBP and DBP were associated with white children and high index of urban quality

of life (UQoL), which represents the individual's social background, as measured by several indicators such as family income, health status, social assistance, education, and housing conditions.

The present study has some limitations: it did not assess socioeconomic status, time spent on physical exercises, which activities were practiced, nor even the level of sedentary lifestyle. The lack of data on nutrition, family history, and waist circumference, the latter being an important anthropometric measurement as an indicator of cardiovascular health, should also be mentioned as limitations of this study. Therefore, it is suggested that further studies are conducted in order to establish a more accurate picture.

Conclusion

The findings of the present study show that the levels of prevalence of overweight, obesity, and %BF are high in schoolchildren, especially in females. Additionally, increased levels of systolic blood pressure in males highlight the need for early intervention through more effective public health campaigns. These data are alarming, as children and adolescents with these alterations have increased risk to develop non-transmissible chronic diseases as adults. The percentage decrease in normal blood pressure levels, both systolic and diastolic, although lacking statistical significance, is still relevant as it demonstrates a regression in the profile of the studied group.

Therefore, the importance of diagnosing obesity and/or arterial hypertension in this age group is emphasized in order to identify individuals with BP alterations, as well as who have risk factors for future alterations.

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