Original Article

Obesity and Its Association with Other Cardiovascular Risk Factors in School Childrenin Itapetininga, Brazil

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Summary

Background: **Paucity of data on childhood obesity and cardiovascular risk in Brazil.**

Objective: **To determine the prevalence of hypertension, dyslipidemia, obesity and their correlations in a sample of school children in Itapetininga, State of Sao Paulo, Brazil.**

Methods: **Cross-sectional study with systematic collection of anthropometric data (weight, height, waist circumference, BMI and blood pressure levels) and determination of glucose, total cholesterol, LDL, HDL, uric acid, and apolipoproteins A and B in a random sample representative of school children from the public education system in Itapetininga, State of Sao Paulo. For data analysis, we used population parameters from the NCHS curves (2000), blood pressure categories from NHBPEP (2004), and the serum cholesterol levels proposed by the AHA for children and adolescents (2003).**

Results: **A total of 494 children and adolescents participated in the study. Of these, 11.7% had HBP, 51% increased total cholesterol, 40.5% increased LDL-cholesterol, 8.5% increased triglycerides, and 6.1% low HDL-cholesterol levels. Mean (± standard deviation) TC, HDL-cholesterol, LDL-cholesterol and triglycerides were 172.1(27.9), 48.1(10.0), 105.7(23.1) and 90.9(43.8), respectively. Obesity and overweight were detected in 12.8% and 9.7% of the sample, respectively. Individuals of the obese group had a greater chance of presenting with dyslipidemia and hypertension in comparison with those of the other groups.**

Conclusion: **This study supports the hypothesis of different prevalences of excess weight among school children from the public education system of the northeastern and southeastern regions of Brazil, with higher rates in the latter. Additionally, it demonstrates an association of obesity with dyslipidemia and hypertension in that group. In light of the paucity of Brazilian data on this issue, our study provides important data for further comparisons.**

Key Words: **Obesity; risk factors; child; adolescent; hypertension / epidemiology; dyslipidemias / epidemiology; Itapetininga; Brazil.**

Introduction

Obesity is currently a global pandemic, and represents an important health problem both in developed and developing countries[1]. With a growing incidence in childhood, this problem is even more alarming when its progression and associations are considered. The multiple associated comorbidities increase the cardiovascular mortality risk and reduce the quality of life in adulthood. Among the different situations associated with adult obesity, hypertension, dyslipidemia and alterations in glucose metabolism have also been found in children with excess weight. In this age group, early vascular complications have also been detected, and they are as feared as those in adults, particularly when their progressive character is considered[2]. According to recent forecasts, the impact of obesity and its comorbidities, despite the technological advancements, may lead the current generation of children to be the first to have a shorter life expectancy than their parents[3].

In light of such a grim outlook, the characterization and updating of clinical and laboratory limits for the definition of obesity, high blood pressure (HBP), and dyslipidemia have been constant matters of concern. Guidelines developed by specialists in research groups under the auspices of important medical societies and reputable health agencies are available for utilization[4-6]. The application of these guidelines permits the knowledge of the real extent of the problem in the most different populations and the comparison among groups worldwide.

The Brazilian population has the peculiarity of having been formed by a large miscegenation process between different ethnic groups of blacks, Caucasians, Indians, Hispanics and eastern populations. This characteristic makes it unique, so that the extrapolation of data obtained in other populations is difficult, and this underscores the need for a better assessment of the prevalence of childhood obesity and its association with other comorbidities in this population group.

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The objective of this study was to evaluate the prevalence of childhood obesity and its association with dyslipidemia, HBP, alterations in glucose metabolism, uric acid, and apolipoprotein fractions A and B in a population of school children from the interior of the State of Sao Paulo, and to compare these data with those obtained in other regions of the country.

Population and methods

This cross-sectional study was conducted between April and December, 2001, and included a representative sample of the population of school children from the public education system of the rural and urban zones of the city of Itapetininga (population estimated at 143,097 inhabitants in 2006)[7]. In the schools, ten percent of the students in each classroom were randomly selected, making up a total of 494 students including children and adolescents of both genders with ages between 2 and 19 years.

After a written informed consent was obtained from their parents and guardians, all participants were evaluated by means of a systematic data collection. Clinical history was taken, physical examination was performed with emphasis on anthropometric data such as weight, height, waist and hip circumferences and blood pressure levels, and blood was collected for glucose, total cholesterol (TC), LDL-C, HDL-C, apolipoprotein A (Apo A), apolipoprotein B (Apo B) and uric acid determinations.

Weight and height were measured with a fixed scale and stadiometer both calibrated and certified by INMETRO (*Instituto Nacional de Metrologia* – National Measurement Institute) to the nearest 0.1 kg and 0.1 cm, respectively. Body mass index (BMI) was calculated from weight and height, using the formula weight (kg)/height (m)^2. BMI percentile (BMIp) by age for each child/adolescent participating in the study was calculated using the parameters from children population curves of NCHS – CDC (Centers for Disease Control and Prevention – USA). The total sample was divided into three groups by BMIp ranges, considering the group without excess weight (WEW) that with BMIp lower than 85, the group with overweight, that with BMIp between 85 and 94 (≥ 85 and ≤ 94), and the group with obesity that with BMIp greater than 95[5].

Hip and waist circumferences were measured with a flexible tape measure to the next 0.1 cm at the iliac crests and at the midpoint between the iliac crests and the costal margin, respectively.

Blood pressure was measured in the right arm with the child or adolescent sitting at rest for at least five minutes with the arm positioned at the same level of the heart. Calibrated sphygmomanometers with proper width and length were used, considering the distance between the olecranon and acromion, and the circumference of the arm in which blood pressure was measured. Based on the parameters of age, sex and height, the mean between three measurements was converted into standard deviations and blood pressure percentiles (BPp). Next, the sample was categorized into three groups as proposed by the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents (NHBPEP)[4]. The group with normal blood pressure was considered that in which the students had BPp lower than 90, the pre-hypertension group included students with BPp between 90 and 94 (≥ 90 and ≤ 94), and the hypertension group included students with BPp higher than 95.

Blood was collected after a 12-hour fast. Automated enzymatic methods were used for TC, HDL-C, and triglyceride determinations, and LDL-C was obtained using the Friedewald formula[8]. According to the guidelines of the American Society of Cardiology for dyslipidemia in children and adolescents, the biochemical determinations of plasma lipids were categorized as normal or abnormal. Thus, LDL-C ≥ 110 mg/dL, HDL-C < 35 mg/dL, CT ≥ 170 mg/dL, and triglycerides ≥ 150 mg/dL were considered abnormal levels[6].

Blood glucose and uric acid were determined by automated enzymatic methods, and ApoA and ApoB were determined by immunonephelometry.

The Statistical Package for the Social Sciences (SPSS) software version 9.0 was used for statistical calculations, and a 5% level of significance ($p \leq 0.05$) was considered to rule out the null hypothesis in all analyses. ANOVA was used in the comparison of mean systolic and diastolic blood pressures, weight, height, waist circumference, waist-height ratio, HDL-C, LDL-C, triglycerides, TC, blood glucose, uric acid, Apo A, and Apo B by the BMI percentile ranges established. In order to identify the origin of the differences found between the means, the Turkey and Dunnett T3 tests were used for variables with and without homogeneity in the sample, respectively. The chi-square test was used for the analysis of the association between the presence of obesity (BMIp ≥ 95) and the other categorized variables, presence of high blood pressure (BPp ≥ 95), and presence of abnormal levels of total cholesterol, HDL, and LDL.

The study was approved by the Ethics Committee of *Instituto do Coração da Universidade de São Paulo*.

Results

The assessment of the group of 494 children/adolescents revealed a greater and significantly older population of girls (59.9%) in relation to boys. However, in relation to the population curve used as a reference for this study, the mean Z-score obtained for girls' height was similar to that obtained for boys[5]. Both genders had a lower mean height than that found in the reference mentioned above (Table 1). HBP was detected in 11.7% of the sample. TC, LDL-C and triglyceride levels were increased in 51%, 40.5% and 8.5%, respectively. HDL-C was reduced in 6.1% of the tests made (Table 2). Considering the whole sample, the mean (± standard deviation) CT, HDL-C, LDL-C and triglycerides were 172.1(27.9), 48.1(10.0), 105.7(23.1), and 90.9(43.8), respectively (Figure 1). According to the stratification by BMI categories (WEW group, overweight group and obese group), 9.7% of the sample were overweight and 12.8% were obese. This stratification also showed significant differences among all the groups only for the means of the weight, waist circumference and systolic blood pressure variables (Figure 2a, 2b, 2c and Table 3). For the other anthropometric variables, at least two of the groups did not reach significantly different means between themselves (Table 3). None of the serum levels was significantly different among all groups. Between the WEW and the obese groups, serum levels were different for total cholesterol, LDL, triglycerides and uric acid. Between the overweight and the obese groups, differences were found only for triglycerides, and between the WEW and the overweight groups, only for uric acid. Blood glucose, HDL and apolipoproteins A and B were not different among the groups (Table 3 and Figure 3).

The incidence of systolic and diastolic HBP alone or in combination, and of TC ≥ 170 mg/dL, LDL ≥ 110 mg/dL and triglycerides ≥ 150 mg/dL was significantly higher in the obese group in comparison with the other groups.

Discussion

The present study characterized the presence of cardiovascular risk factors and their association with overweight and obesity in a sample of school children in the interior of Sao Paulo, southeastern Brazil. The use of parameters internationally suggested for the analysis of weight disorders, lipid abnormalities, and blood pressure permitted the construction of data that can be compared not only with other Brazilian regions, but also with international population groups[4-6].

The representative sample of the study population was characterized by the inclusion of a greater number of girls who were also older than the boys evaluated. Since no difference was observed in the Z-score of the standard growth curve used to compare height between genders, the analysis of anthropometric and biochemical variables was made for the whole group together.

Excess weight

Interestingly, the prevalence of obesity in the male sample of the group studied was higher than that of overweight, which

Table 1 - **Characterization of the sample of students from the public education system in the city of Itapetininga by age and Z-score for height, calculated using NCHS:2000 CDC Growth Charts[5] data, compared by gender, 2001.**

	Male		Female		Statistical Significance
	Mean	SD	Mean	SD	
Age	9.31	3.87	10.41	3.92	*p*<0.01
Z-score for height	-0.13	1.06	-0.31	1.01	*p*=0.06

Table 2 - **Characterization of the sample of students from the public education system in the city of Itapetininga by gender, presence of high blood pressure, and changes in lipid profile in the whole sample and in BMI categories, 2001.**

	WEW*	Overweight	Obese	Total
Number of patients	383 (77.5%)	48 (9.7%)	63 (12.8%)	494
Male	143 (72.2%)	17 (8.6%)	38 (19.2%)	198 (40.1%)
Female	240 (81.1%)	31 (10.5%)	25 (8.4%)	296 (59.9%)
High blood pressure	34 (8.9%)	6 (12.5%)	18 (28.6%)	58 (11.7%)
TC ≥ 170 mg/dL	183 (47.8%)	22 (45.8%)	47 (74.6%)	252 (51%)
LDL-C ≥ 110 mg/dL	141 (36.8%)	24 (50%)	35 (55.6%)	200 (40.5%)
HDL-C < 35 mg/dL	23 (6.0%)	2 (4.2%)	5 (7.9%)	30 (6.1%)
Triglycerides≥150 mg/dL	18 (4.7%)	7 (14.6%)	17 (27%)	42 (8.5%)

** WEW – without excess weight.*

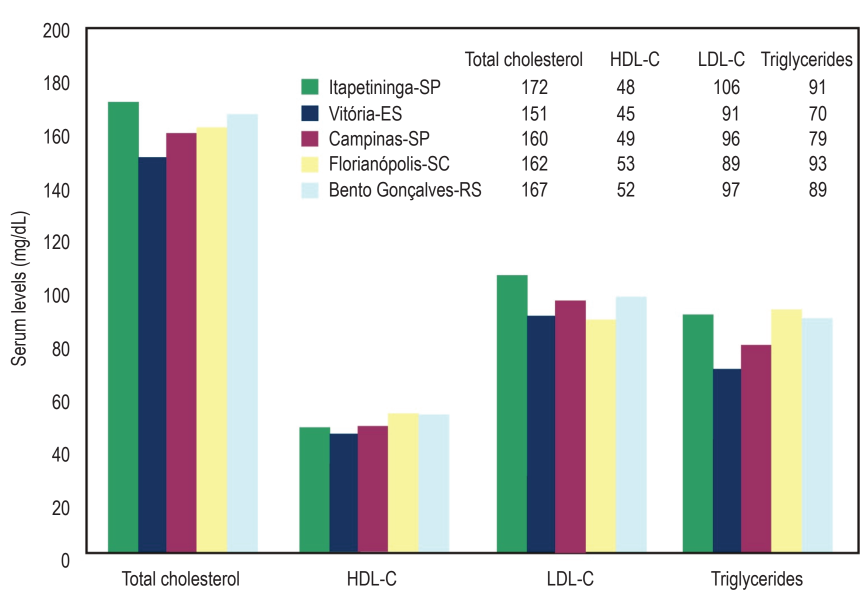

Figure 1 - Mean serum levels of total cholesterol, LDL-C, HDL-C, and triglycerides in the present study (Itapetininga-2001) and in four other studies conducted in Brazil[21-24].

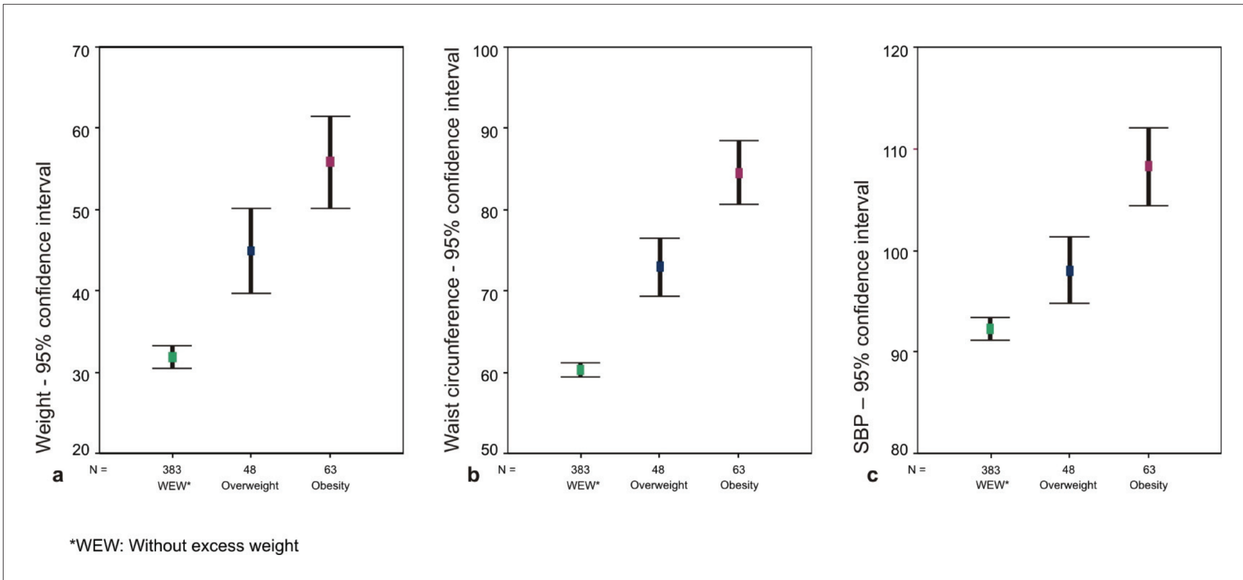

Figure 2 - a, b and c - 95% confidence interval for weight, waist circumference, and systolic blood pressure (SBP) among the BMI categories in the sample of students from the public education system in the city of Itapetininga, 2001.

Table 3 - Sample of students from the public education system of the city of Itapetininga divided into groups by BMI categories (without excess weight, overweight and obesity) and comparative analysis of the means of data collected from physical examination and laboratory determinations, 2001.

	WEW	SD	Overweight	SD	Obese	SD
Age (years) n.s.	9.84	3.98	10.6	3.8	10.27	3.76
Weight (Kg) *	31.89	14.02	44.93	17.79	55.81	22.57
Height (m) †	1.33	0.2	1.39	0.19	1.40	0.18
SD of height by age †‡	-0.34	1.02	-0.17	0.75	0.29	1.12
SBP (mmHg) *	92.25	11.38	98.02	11.33	108.25	15.16
DBP (mmHg) †‡	61.93	8.65	64.17	8.21	70.0	10.92
SD of SBP by age and height †‡	-0.84	0.95	-0.48	1.04	0.43	1.27
SD of DBP by age and height †‡	0.22	0.81	0.33	0.84	0.81	0.93
Waist circumference (cm) *	60.31	9.08	72.98	12.29	84.55	15.51
Waist/hip ratio †‡	0.86	0.08	0.89	0.05	0.95	0.12
Total cholesterol (mg/dL) †	169.21	26.99	175.2	31.59	186.98	26.06
LDL(mg/dL) †	103.75	21.8	112.54	31.1	113.04	21.75
HDL(mg/dL) n.s.	48.7	10.43	45.85	7.58	46.41	8.65
Triglycerides(mg/dL) †‡	83.43	33.87	96.43	46.88	132.0	66.6
Glucose(mg/dL) n.s.	85.53	8.36	86.41	6.37	86.87	7.15
Uric acid(mg/dL) †,§	4.05	0.87	4.77	1.16	5.32	1.35
Apo A n.s.	131.08	28.14	123.22	28.67	126.11	26.19
Apo B n.s.	89.49	45.77	91.85	24.64	99.07	19.83

*WEW – without excess weight. n.s. – non-significant difference between groups; * – significant difference between the three groups; † – WEW different from obese, ‡ – Overweight different from obese; § – WEW different from overweight.*

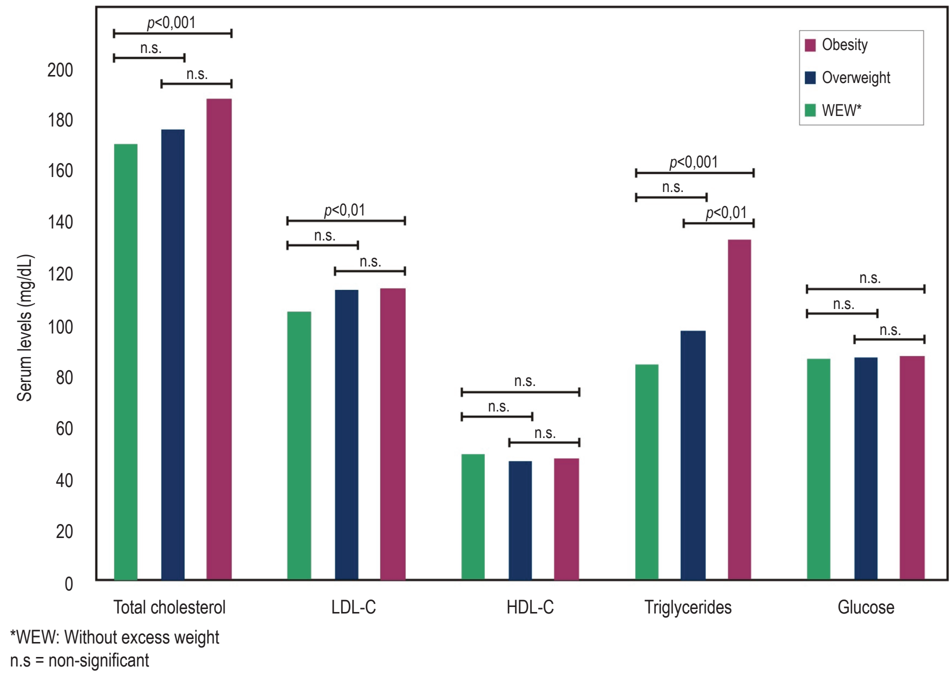

***Figure 3 -** Mean serum levels of total cholesterol, LDL-C, HDL-C, triglycerides, and glucose across BMI categories, with statistical differences between them, in the sample of students from the public education system in the city of Itapetininga, 2001.*

was reflected in the analysis of the whole group. In terms of Brazilian samples, this characteristic was not exclusive of our study, and was also detected in a study conducted in the city of Santos, State of Sao Paulo. Unlike the results presented here, the higher number of obese boys in relation to overweight boys in the study of the city of Santos was not enough to determine a higher prevalence of obesity when the whole group was analyzed[9]. Obesity was also more prevalent than overweight in a large American study that assessed weight disorders and hypertension in school children classified by ethnicity. In the latter study, the frequency of obesity among the Hispanic population was also higher than that of overweight[10].

Environmental, socioeconomic and even cultural factors have been suggested as determinants of the disproportionate increase of obesity among different ethnias in the USA[11]. Because of the large miscegenation of our population, the definition of ethnicity is impossible in our group. Additionally, the design of the present study does not allow an adequate causal inference for this phenomenon, nor can an effect of random variability be ruled out in the sample enrolled.

Because of the different methodologies applied for the definition of obesity in the several studies using Brazilian samples, this case series could be compared with at least five other series of the Northeastern and Southeastern regions (Figure 4)[9,12-15]. The series conducted in the Northeastern region included two capital cities, Recife (State of Pernambuco) and Maceió (State of Alagoas), and a large city in the interior of the State of Bahia, Feira de Santana (population estimated at 535,826 inhabitants in 2006)[7]. The Southeastern series that were compared to ours included two cities in the State of São Paulo: its capital and a coastal city, Santos (population estimated at 418,375 inhabitants in 2006)[7]. The Recife's series showed more than double the prevalence of excess weight when compared to the other cities in the same region (Figure 4)[13-15]. The analysis of a population formed exclusively from the private education system for the middle and upper classes seems to have been a determinant factor for this finding. When students from the public and private education systems were separated in the studies conducted in Maceió and Feira de Santana, significant differences were found in both, showing a higher incidence of overweight and obesity among students from the private system[13-15]. In these two studies, the prevalence of excess weight in the subgroup of private schools was lower than that of Recife's study. Santos' series showed the same epidemiological pattern of increased incidence of excess weight among students from the private education system[9]. The series from São Paulo's capital assessed only students from the public system and, in comparison with the other subgroups of students from public schools both from the northeastern and the southeastern series, showed the highest prevalence of obesity[9,12,14,15].

The present study was conducted in a smaller city and assessed only students from the public education system, detecting excess weight in approximately 20% of the study sample, a rate similar to that of the subgroup from the public education network studied in Santos. In comparison with the subgroups from the public system of the northeastern studies, the prevalence of excess weight was more than two-fold higher than that found in Feira de Santana (9.2%) and Maceió (10.8%)[14,15].

In summary, the joint analysis of this study and the others mentioned suggests a higher prevalence of excess weight among students from the private education system when compared with the local reference population, and a tendency to higher

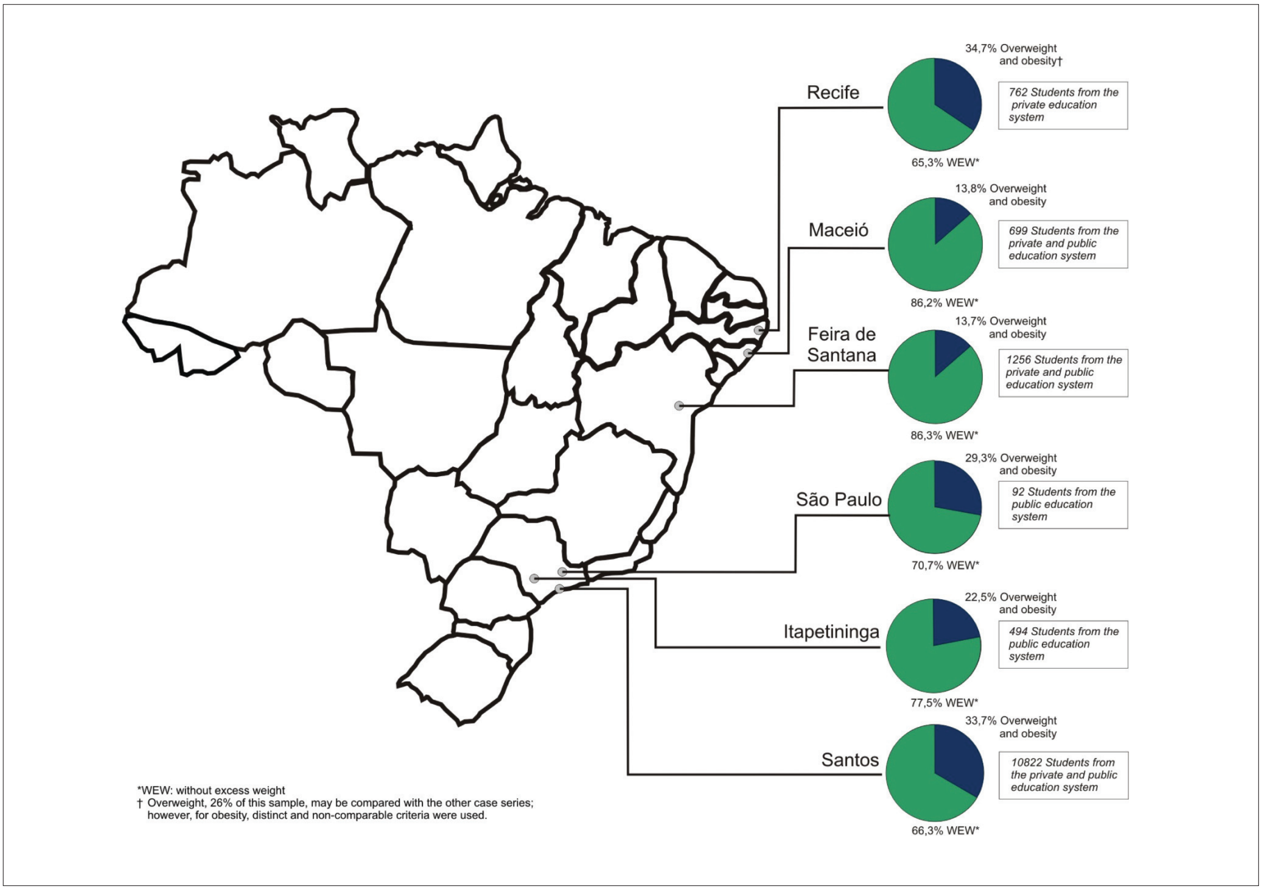

Figure 4 *- Overweight and obesity percentages in the present study (Itapetininga-2001) and in four other studies conducted in Brazil[9,12-15].*

excess weight among students from the southeastern region in relation to those from the northeastern region, particularly when students from the public system are considered.

High Blood Pressure

A progressive increase in diastolic and systolic blood pressure levels was demonstrated in this study when the predefined weight categories from the WEW to the obesity group were compared. In this evaluation, the differences in systolic blood pressure levels were statistically significant across all weight categories defined. A shift in the etiology of hypertension in children, with a higher incidence of primary hypertension in relation to secondary hypertension, which was historically more prevalent in this age range, has been associated with obesity[16]. The analysis of the data presented here showed that the presence of obesity, in comparison to the other pooled categories, was associated with a higher prevalence of HBP. The finding of a linear increase in blood pressure levels with increasing BMI found in this patient series corroborates the findings of other series[17,18]. Several studies were conducted with the objective of identifying the prevalence of HBP among children from different Brazilian regions. Of these, the study conducted in the city of Cuiabá, central western Brazil, used the same NHBPEP diagnostic parameters applied here; therefore, comparisons between both could be made. In that study, HBP was assessed in three different measurements taken with a large interval between them. This methodology showed a significant reduction in pressure levels between the first and subsequent measurements[19]. According to the authors' recommendations, we considered the first measurement taken in that study to compare with the data from our series. Although the methodology used in our study also included three measurements, with no substantial interval between them. With small variations between the pressure levels detected, we chose to calculate the arithmetic mean between the three measurements to define the individual blood pressure level. Thus, Cuiabá's study found a 8.3% prevalence of hypertension therefore lower than the 11.7% found in our study.

Dyslipidemia

Changes in lipid profile were remarkable among the students from Itapetininga. Half of the entire group presented elevated TC, and increased LDL-C was the most frequent disorder in the whole sample. In adults, the presence of hypertriglyceridemia and low HDL-C levels are characteristic of obesity disorders[20]. In this case series, the presence of childhood obesity determined a greater chance of finding high levels of total cholesterol, LDL-C and triglycerides, but not of finding low HDL-C cholesterol, in the comparison with the non-obese children. Despite using the same methodology for the determination of serum total cholesterol, LDL-C and HDL-C levels, some studies in the Brazilian literature compared the analyses with diagnostic criteria of dyslipidemia which do not fully overlap those used in the present study. Thus, the mean levels determined in four other studies conducted in Brazil may be presented comparatively (Figure 1)[21-24], but the prevalence of dyslipidemia can only be compared with two of them[21,22]. In these two studies, the cut-off point of 170 mg/dL for total cholesterol determined the presence of hypercholesterolemia in 35% of the students from the public education system assessed in Campinas, and in 28% of the students from the public and private education systems in Florianópolis. In both cases, the prevalence was lower than that of 51% found in our case series in Itapetininga. The similar population characteristics of the study conducted in Campinas, which is also in the interior of the State of Sao Paulo, makes it difficult to understand the difference in the prevalence of dyslipidemia found here. As suggested by that study's authors, the exclusion of cases known to be related to hypercholesterolemia may have contributed to a lower prevalence of dyslipidemia in their case series.

Conclusion

The characterization of cardiovascular risk factors from the perspective of the study of obesity in a pediatric case series provides useful data for the understanding of this condition, its interactions and peculiarities in the children and juvenile population. Using a data analysis that permits comparisons within the Brazilian territory, the present study provides elements for the hypothesis of distinct prevalences of excess weight among students from the public education system in the northeastern and southeastern regions, with higher rates in the latter. Additionally, we found high rates of high blood pressure and dyslipidemia, which are not only more frequent in the presence of obesity, but also showed higher levels with increasing BMI percentiles.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This study is not associated with any post-graduation program.

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