# HIGH BLOOD PRESSURE, OVERWEIGHT AND ABDOMINAL OBESITY IN CHILDREN AND ADOLESCENTS

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**ABSTRACT**

The purpose of the present study was to verify the frequency of high blood pressure in boys and girls aged between 10 and 16 years old, analyzing its association with body overweight and abdominal obesity. A total of 764 children and adolescents (365 boys and 399 girls) from five public schools in Curitiba had their height, body weight, waist circumference and resting systolic and diastolic blood pressures measured. Student's t-test and Chi-square test were used. The level of significance was set at $p<0.05$ for all analyzes. The frequencies of blood pressure and body overweight in the students were equal to 18.6% and 30.8%, respectively. Abdominal obesity was present in 33.1% of the students. In this study, the prevalence of elevated blood pressure constituted a factor to investigate.

**Key-words:** Blood pressure. Students. Overweight. Abdominal obesity.

## INTRODUCTION

Systemic hypertension (SH) is a multifactorial disease that, although predominant in adulthood, may present its first signs in childhood or adolescence (SALGADO; CARVALHAES, 2003). In recent years, due to inadequate lifestyle, there has been an increase in SH cases among American children and adolescents (DIN-DZIETHAM et al., 2007; OSTCHEGA et al., 2009). In Brazil, SH is currently considered a problem of public health, and it is estimated that 3.5 million children are hypertensive and need treatment (SOCIEDADE BRASILEIRA DE HIPERTENSÃO, 2007).

The high incidence of SH is worrisome, because high blood pressure is an important risk factor, independent of cardiovascular disease, cerebrovascular accident and kidney disease, and is associated with the development of coronary atherosclerosis and left ventricular hypertrophy, problems that can onset during childhood (SALGADO; CARVALHES, 2003). In addition, a longitudinal study revealed that the risk conditions found in childhood tend to manifest and worsen in adulthood (FREEDMAN et al., 2005).

The etiopathogeny of the SH has not been totally clarified yet, but the influence of environmental and genetic factors have been recognized (MAGALHÃES et al., 2002). Some environmental factors traditionally associated with SH in adults have demonstrated association with increase in blood pressure in children and adolescents, including body overweight and abdominal obesity (RIBEIRO et al., 2010).

The scientific literature demonstrates that body overweight associates with high blood pressure in children and adolescents (MOURA et al., 2004; ROSA et al., 2006; BOTTON et al., 2007; NEUHAUSER et al., 2009), and there is evidence that the frequency of high blood pressure among children increases progressively with the increments of body mass index (SOROF et al., 2004). On the other hand, it has been confirmed that the reduction in body mass index brings on pronounced decreases in the rates of blood pressure in obese and hypertensive children and adolescents (LEITE, 2005). For this reason, the reduction in body weight is the main purpose of the non-pharmacological treatment of SH (GIDDING, 2002).

Other studies have also confirmed a linear relationship between blood pressure and body mass index (BOTTON et al., 2007; RIBEIRO et al., 2010), although this anthropometric index is not regarded as a good predictor of body adiposity in children and adolescents (FREEDMAN et al., 2009), because it does not distinguish fat mass from lean mass (DIETZ; BELLIZZI, 1999).

Excessive fat stored in the abdominal area, on the other hand, has been considered by some researchers as a more important determinant than total adiposity for the development of high blood pressure (DANIELS et al., 1999; ROSA; RIBEIRO, 1999; KAHN; IMPERATORE; CHENG, 2005; LEE; BACHA; ARSLANIAN, 2006), possibly due to its association with insulin resistance (FERREIRA; ZANELLA, 2000).

Abdominal adiposity can be assessed through the waist circumference measure, which is a low-cost alternative, easy to perform and presents good reproducibility (WELLS; FEWTRELL, 2006). In spite of the simplicity of this assessment method, the waist circumference correlates strongly with the visceral fat and the SH, regardless of body mass index (LEE; BACHA; ARSLANIAN, 2006). Thus, its use, along with body mass index, has been recommended for the assessment of children and adolescents regarding cardiovascular risk and SH (JANSSEN et al., 2005; LEE; BACHA; ARSLANIAN, 2006).

Based on these evidences, this study aimed to verify the frequency of high blood pressure in students, of both genders, from public schools in the city of Curitiba, state of Paraná, Brazil, analyzing its association with body overweight and abdominal obesity.

## MATERIAL AND METHODS

### Study design

This cross-sectional, descriptive and comparative study was conducted between August 2007 and September 2008, after authorization by Curitiba's Secretariat of Education, Paraná. The research protocol was designed in accordance with the guidelines established by Resolution 196/96 of the National Health Council on research involving humans, and registered under number CEP/SD: 403.083.07.07.

### Subjects

The study counted with the participation of 764 students (365 boys and 399 girls) aged between 10 and 16 years old, from five public schools in Curitiba, Paraná, and selected through systematic sampling. Only those students who accepted to participate in the research and handed in the informed consent form signed by their parents or legal guardians were assessed.

The sample size was calculated by means of the software EpiInfo, version 3.5.1, considering the number of students enrolled in the five municipal schools assessed, level of confidence of 95% and sampling error of 5%. The prevalence considered was 50%. Based on these parameters, the sample calculated was composed of 673 students, resulting from the sum of the samples calculated for each school.

### Procedures

All assessments were carried out during school hours, in the morning. The anthropometric measures were obtained by respecting the norms of the Anthropometric Standardization Reference Manual *(*LOHMAN; ROCHE; MARTOREL, 1988), considering as valid the mean value of the three measures. Height was measured in centimeters (cm), at the end of a maximum inspiration, by means of a Wiso® wall-mounted stadiometer, with resolution of 0.1

cm. The subjects stood in orthostatic position, wearing no shoes and with their feet together, with the upper surface of the heels, pelvic and scapular waists and occipital region in contact with the wall, and with their heads in the Frankfurt horizontal plane. Body mass was measured in kilograms (kg), on a Plenna portable digital scale, Sport model, with maximum capacity of 150 kg and resolution of 100 grams. The subjects stood at the center of the platform, barefoot, with their arms along their body and wearing school uniform (pants and shirt). For the diagnosis of body overweight, the body mass index - obtained by dividing the individual's body mass by the square of his/her height - was classified according to the references for the Brazilian population, by age and gender (CONDE; MONTEIRO, 2006).

Waist circumference was measured in centimeters, with a flexible and inextensible measure tape, with resolution of 0.1 cm, applied right above the iliac crest, parallel to the ground. The subjects remained stood, with their feet together, loose abdomen and arms hanging beside their body. Values higher or equal to the 75th percentile were considered as abdominal obesity, according to age and gender (FERNANDEZ et al., 2004).

The assessment of growth stages was based on the self-assessment of the development of pubic hair (P1-P5), in accordance with the staging proposed by Tanner (1986). For both genders, students without pubic hair were considered as prepubertal (P1), those with development of pubic hair between P2 and P4 as pubertal, and those with P5 development of pubic hair as pospubertal. In the case of the girls, the report of menarche was considered for the classification of the pospubertal stage, preferably for the assessment of the development of pubic hair.

The systolic blood pressure (SBP) and the diastolic blood pressure (DBP) were measured during a single occasion, after a minimum rest of 5 minutes. The students seated with their right arms rested at the heart level. A Mercurial Sphygmomanometer Premium, model CE 0483 was used, with a cuff that fitted the individual's arm, Three measures were obtained with an interval of two minutes in between, and the mean of the two last measures was used to analysis blood pressure. The values of SBP and DBP obtained were classified into three stages, according to the specific tables in percentiles for children and adolescents, by age, gender and height: 1) below average (SBP and/or DBP $<50^{o}$); 2) adequate (SBP and/or DPB $50^{o}<90^{o}$ and if lower than 120/80 mmHg); 3) and hypertensive measures (SBP and/or DBP $\geq 90^{o}$ or $\geq$120/80 mmHg) (NATIONAL HIGH BLOOD PRESSURE EDUCATION, 2004).

### Statistical treatment

Data were presented through descriptive statistics, tables and graphs. Student's t-test was used to analyze the differences between genders and groups, and the Chi-square test was used to investigate the association of high blood pressure with genders, excessive body weight and abdominal obesity. For all analyzes, the level of significance was set at $p<0.05$.

## RESULTS

From the initial sample, composed of 772 subjects, six girls (0.78%) and one boy (0.13%) were excluded for presenting low body weight, and one boy (0.13%) for being taking a beta-blocker medicine, which could alter blood pressure. Thereby, 764 students participated in the study - 365 boys (47.8%) and 399 girls (52.2%).

Comparing genders, significant differences have been observed only in the means of height and SH, which were higher among boys. Boys and girls have presented no differences

regarding the means of age, body mass, body mass index, waist circumference and DBP (Table 1).

**Table 1** – Characteristics of the students, by gender.

| Variables | Boys | Girls | Total | P |
|---|---|---|---|---|
| | (n = 365) | (n = 399) | (n = 764) | |
| Decimal age | 12.6±1.6 | 12.4±1.4 | 12.5±1.5 | 0.1142 |
| Body mass (kg) | 47,9±12.7 | 47.2±11.2 | 47.6±11.9 | 0.4085 |
| Height (cm) | 154.2±11.8 | 152.8±8.4 | 153.5±10.2 | 0.042 8* |
| BMI (kg/m$^2$) | 19.9±3.6 | 20.1±3.6 | 19.9±3.6 | 0.5487 |
| WC (cm) | 70.9±9.5 | 72.1±9 | 71.6±9.3 | 0.0955 |
| SBP (mmHg) | 104±14 | 102±13 | 103±14 | 0.0207* |
| DBP (mmHg) | 65±11 | 65±11 | 65±11 | 0.6467 |

Values expressed as mean±SD; * significant difference to p<0.05; BMI = body mass index
WC = waist circumference;
SBP = systolic blood pressure; DBP = diastolic blood
pressure

In the comparison between groups, it has been verified that the group with excessive body weight has presented significantly higher means in the anthropometric variables, SBP ($p < 0.0001$) and DBP ($p < 0.0001$) than the group with adequate body weight. Age and height were similar between the groups with excessive body weight and adequate body weight (Table 2).

**Table 2** – Characteristics of the students by BMI profile.

| Variables | Overweight. | Adequate weight | P |
|---|---|---|---|
| | (n = 235) | (n = 529) | |
| Decimal age | 12.3±1.4 | 12.5±1.5 | 0.1533 |
| Body mass (kg) | 57.5±11.6 | 43.2±9 | 0.0000* |
| Height (cm) | 154.4±9.3 | 153.1±10.5 | 0.0904 |
| BMI (kg/m$^2$) | 23.9±3.2 | 18.2±1.9 | 0.0000* |
| WC (cm) | 80.5±8.4 | 67.6±6.4 | 0.0000* |
| SBP (mmHg) | 108±13 | 101±13 | 0.0000* |
| DBP (mmHg) | 69±11 | 63±11 | 0.0000* |

Values expressed as mean±SD; *significant difference to p<0.05; BMI = body mass index; WC = waist circumference; SBP = systolic blood pressure; DBP = diastolic blood pressure.

Among the 764 students assessed, 18.6% (n=142) have presented high blood pressure, 46.6% (n=266) had adequate blood pressure, and 34.8% blood pressure below average. Comparing genders, it has been observed that the frequency of high blood pressure was 18.1% (n=76) in the male group (n=365) and 19% (n=66) in the female group (n=399), and there were no statistically significant differences ($\chi^2$=0.8107; p=0.6667) (Figure 1).

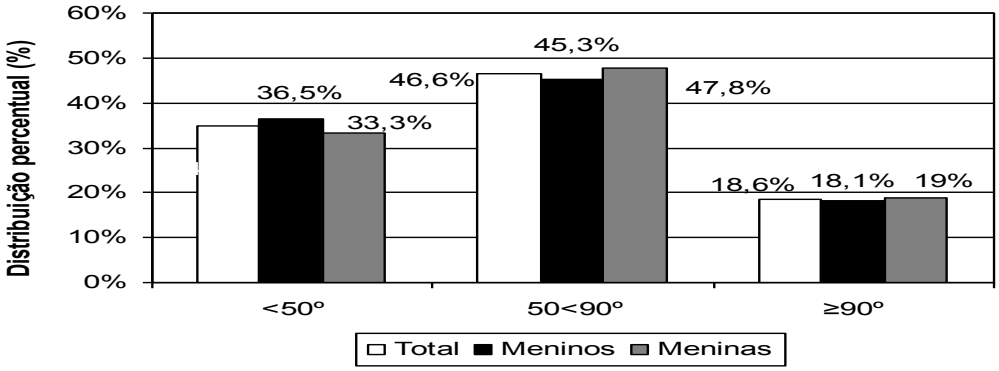


**Figure 1** – Blood pressure percentiles acoording gender

As for body mass index profile, excessive body weight has been observed in one third of the students (30.8%; n=235) and adequate body weight in 69.2% (n=529), proportion that also remained in the analysis by gender (boys: 32.6%, n=119; girls: 29.1%, n=116), in similar proportions ($\chi^2$=1.12; p=0.2909) (Figure 2).

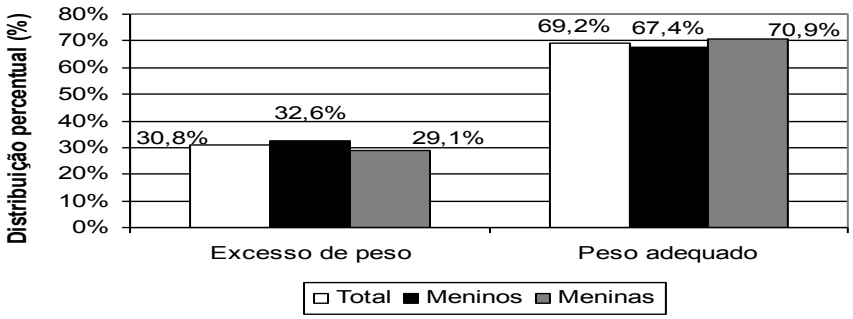


**Figure 2 –** Profile of the body mass index according gender

The analysis of the waist circumference measure has also revealed that one third of the children and adolescents have abdominal obesity (33.1%; n=253) and 66.9% (n=511) have adequate waist circumference. In the assessment by gender, it has been verified that abdominal obesity has been more frequent among girls (37.1%; n=148) than among boys (28.8%; n=105), with significant difference ($\chi^2$=5.97; p=0.0146) (Figure3).

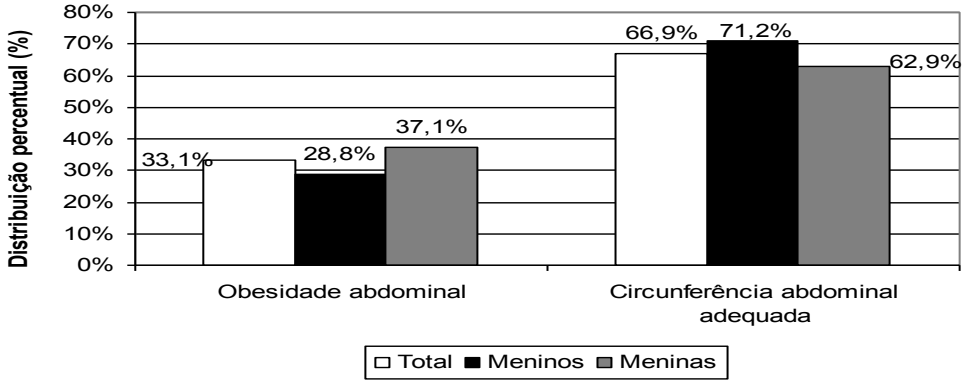


**Figure 3 –** Frequence of abdominal obesity according gender

When comparing the blood pressure of those girls with excessive body weight (n=116) and adequate body weight (n=283), it has been observed that high blood pressure was twice as

frequent in girls with excessive body weight (28,4%; n=33) as in those with adequate body weight (15.2%; n=43), indicating association between excessive body weight and high blood pressure ($\chi^2$=12.5657; p=0.0019)

The results were similar for males, showing that those boys with excessive body weight (n=119) also had higher proportion of high blood pressure (27.7%; n=33) than those boys with adequate body weight (n=246), among which 13.4% (n=33) has presented high blood pressure ($\chi^2$=17.5783; p=0.0002).

Another analysis has compared the frequencies of high blood pressure among girls with abdominal obesity (n=148) and those with adequate waist circumference (n=251). This analysis has demonstrated higher proportion of high blood pressure in the group with abdominal obesity (23.6%; n=35) than in the group with adequate waist circumference (16.3%; n=41), revealing a significant difference between groups ($\chi^2$=16.4404; p=0.0003)

The rates of high blood pressure of the groups with abdominal obesity (n=105) and adequate waist circumference (n=260) have also been compared in males. Contrarily to what has been observed in the female group, those boys with abdominal obesity have presented a proportion of high blood pressure (21.9%; n=23) similar to that of boys with adequate waist circumference (16.5%; n=43) ($\chi^2$=4.22487; p=0.1210)

## DISCUSSION

The prevalence of SH has been increasing among children and adolescents all over the world (SALGADO; CARVALHES, 2003; ARAÚJO et al., 2008). In the United States, this population, aged between 8 and 17 years old, presented a prevalence of pre-hypertension and arterial hypertension equal to 9.7% and 3%, respectively, from 2003 to 2006 (OSTCHEGA et al., 2009). Considering this same age group, other researchers showed that the incidence of pre-hypertension and SH has been increasing in the country, where it has verified that between 1988 and 2002 there was an increase of 2.3% in the incidence of pre-hypertension (from 7.7% to 10%) and of 1% in SH (from 2.7% to 3.7%) (DIN-DZIETHAM et al., 2007).

In Brazil, the incidence of SH is around 1% and 13% among children, according to the Brazilian Society of Hypertension (SBH, 2007). This study has observed that 18.6% of the students presented high blood pressure, which agrees with some recent national studies that showed that the incidence of this disease can vary a lot depending on the region studied (12% - 44,7%), due to methodological differences referring to the sampling methods, the size and characteristics of the sample, the quality of the measurement instruments and the technique employed, and the number of measurements and cutoff points to classify blood pressure. Moreover, it is worth stressing that the incidence of SH is also influenced by intervenient variables, given its multifactorial character, which involves both genetic and environmental aspects (MAGALHÃES et al., 2002; FERMINO et al., 2009).

In this research, the rates of high blood pressure are similar among boys and girls, although the mean of SBP has been higher in males (p=0.0207), possibly because this group has also presented higher mean of height (p=0.0428). Other national and international studies have not found any association between genders and high blood pressure (MOURA et al., 2004; SILVA; BALABAN; MOTTA, 2005; FERREIRA; AYDOS, 2010; KELISHADI et al., 2006), corroborating the findings of this study.

Another finding of this research was the high incidence of excessive body weight (overweight or obesity) diagnosed in the students, affecting one third of the individuals assessed. These data confirm the world trend on obesity increase in children and adolescents, both in developed and developing countries (JANSSEN et al., 2004; BUA; OLSEN; SORENSEN, 2007; WANG; MONTEIRO; POPKIN, 2002), as well as the process of

nutritional transition experienced in Brazil in the 1980s and 1990s (MONTEIRO, CONDE, 2000).

It is important to highlight that the frequency of excessive body weight verified in this study (30.8%) is higher than the 16.8% previously verified in the city of Curitiba, in an investigation also conducted with students from public schools and belonging to the same age group as that of the subjects of the present study (LEITE et al., 2003). It is observed, thus, that in the last years the rate of excessive body weight has increased among students from public schools in Curitiba. Researches conducted in previous years in other Brazilian cities have also diagnosed lower rates of excessive body weight, which confirms the secular trend on obesity (CAMPOS; LEITE; ALMEIDA, 2007; PIO; ROSA, 2006; SILVA; BALABAN; MOTTA, 2005; MOURA et al., 2004; RIBEIRO et al., 2009; RIBEIRO et al., 2010).

Comparing genders, the girls and boys of this study have demonstrated similar proportions of excessive body weight. In the scientific literature, the association between gender and excessive body weight is controversial. Some researchers have not confirmed this association in students from public schools, although they have evidenced it in students from private schools, with prevalence of excessive body weight in boys (CAMPOS; LEITE; ALMEIDA, 2007). A higher tendency for excessive body weight has also been observed in boys from public schools in the city of Londrina (ROMANZINI et al., 2008). Diverging results were observed by Magalhães and Mendonça (2003), who verified greater probability of excessive body weight in male adolescents in the Southwest region and the same probability in female adolescents in the Northeast region.

Just as excessive body weight, abdominal obesity has also been found in one third of the students of this study, predominating among females. Studies that have assessed the increase in rates of abdominal obesity in American children and adolescents (LI et al., 2006) and British children and adolescents (McCARTHY; ELLIS; COLE, 2003) have also observed an increase in its frequency, especially in girls.

The increase in the incidence of SH in children and adolescents, according to some authors, is related, partly, to the increase in the rates of excessive body weight and, partly, to the increase in the incidence of abdominal obesity (DIN-DZIETHAM et al., 2007). The results of this investigation have demonstrated that those students with excessive body weight had means of SBP and DBP significantly higher than those with adequate body weight (p=0,0000), probably due to the fact that they had a higher average body mass index too (p=0,0000). In this study, high blood pressure associated with excessive body weight in both genders. Particularly in the female group, the rate of blood pressure above the limits considered normal was two times higher in those girls with excessive body weight, when compared with eutrophic ones. Other researches have also observed this same association in children and adolescents (MOURA et al., 2004; ROSA et al., 2006; BOTTOM et al., 2007; NEUHAUSER et al., 2009).

In relation to abdominal obesity, its association with alterations in blood pressure in the students of this study has occurred only in the female group, to which, perhaps, it is possible to attribute the higher frequency of abdominal obesity observed in this gender in comparison with the boys (p=0.0146). The association with excessive central adiposity (measured by the waist circumference) and high blood pressure had been previously verified by other researchers, which confirm our results (SAVVA et al., 2000).

This study has also confirmed a positive and significant linear relationship of the systolic and diastolic levels with the body mass index and the waist circumference measure, but these correlations were weak, which perhaps is due to the multifactorial characteristic of the SH (MAGALHÃES et al., 2002). This means that factors other than total and central body adiposity can influence the elevation in blood pressure. These results corroborate the findings

of other researchers that verified correlations of the same magnitude between rates of blood pressures and the same anthropometric indicators analyzed in this study (BOTTOM et al., 2007; RIBEIRO et al., 2010).

The correlations and associations observed in this study confirm the current evidence that increase in blood pressure is related to the increment of the body mass index (SOROF et al., 2004), just as the storage of fat in the abdominal region, measured by mechanisms linked to the hyperinsulinemia (GAGLIARDI, 2004).

The present study has demonstrated a relevant prevalence of high blood pressure, especially in those students who have presented excessive body weight and abdominal obesity. The association of excessive body weight and abdominal obesity with changes in blood pressure, verified in this study, proves the importance of preventing excessive body adiposity toward avoiding the elevation in blood pressure in childhood and the consequent increase of the risk for cardiovascular diseases in adult life. The assessments of body weight, height and waist circumference measures, besides the measurement of blood pressure in children and adolescents, should be part of the routine physical examination in schools, because the early diagnosis of excessive adiposity and hypertensive measures can reduce morbidity and prevent the evolution to SH in adult life.

The rates of blood pressure diagnosed in this study should not be faced as prevalence of SH, since they have been based on measures taken at a single occasion; however, they point to the need to monitor children and adolescents aged 10-16 years old, especially those with excessive body weight and abdominal obesity.

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