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# Prevalence and Anthropometric Predictors of High Blood Pressure in Schoolchildren from João Pessoa - PB, Brazil

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## Abstract

**Background:** Arterial hypertension (AH) belongs to the group of cardiovascular diseases with the highest mortality in the world and its onset can occur in childhood.

**Objective:** To evaluate the prevalence of high blood pressure (BP) in schoolchildren from public schools and its association with anthropometric indicators.

**Methods:** The present was a cross-sectional study, consisting of a random sample of 750 schoolchildren aged 6 to 9 years from public schools of the city of João Pessoa, state of Paraiba, Brazil. The data were collected by a previously trained team. BP was measured by auscultation, using a stethoscope and an aneroid sphygmomanometer. The collected anthropometric data were weight, height and abdominal circumference. Chi-square and Student's t association tests were used to compare means, both with a level of significance of 5%. Three logistic regression models were constructed, correlating high BP with the anthropometric variables to find a better prediction model.

**Results:** The prevalence of high BP levels was 13.6%. The body mass index (BMI) variable presented a significant association with the increase in BP levels ($p < 0.0001$) and a higher odds ratio (OR = 1.17). The increase in the BP levels also occurred with the increase in weight ($p < 0.0001$) and abdominal circumference ($p < 0.0001$).

**Conclusion:** The identified association between excess weight with high BP levels emphasizes the need for intervention and for nutritional status control measures, such as dietary education programs aimed at the prevention and treatment of obesity as a risk factor for cardiovascular diseases in the pediatric and older age ranges. (Arq Bras Cardiol 2010; 95(5): 629-634)

**Keywords:** Anthropometry; hypertension; cardiovascular diseases; body mass index; obesity; child.

## Introduction

In the last decades, the processes of demographic and epidemiological transition, accompanied by the process of nutritional transition, characterized by the continuous decrease of malnutrition cases and increasing prevalence of overweight and obesity, have modified the patterns of the occurrence of diseases in the world population, thus contributing to the increase in the prevalence of non-transmissible chronic diseases (NTCD). Obesity, particularly abdominal obesity, occurring also in childhood, are associated with the early onset of arterial hypertension and premature death due to chronic diseases[1-3].

Systemic arterial hypertension (SAH) is the chronic disease with the highest prevalence in the world[4]. In Brazil, studies have shown prevalence rates that vary from 22.3%-43.9% in adults[4,5]. SAH and blood pressure-related diseases are the most relevant factors of cardiovascular mortality and the main risk factors for complications such as cerebrovascular accident (CVA) and congestive heart failure (CHF). Such complications are accountable for a high frequency of hospitalizations, with high medical and socioeconomic costs, as they are the diseases that require the most medical actions, procedures and health services[5,6].

Many children are not correctly diagnosed as having SAH due to the lack of routine assessment and the belief that SAH is rare in childhood[4]. By recognizing that the early diagnosis of obesity and arterial hypertension in children is a good predictor of obesity and chronic-degenerative diseases in adult individuals and that allows the use of prevention measures and early treatment, contributing to the public health policies directed at the studied population, the present study aimed at investigating the prevalence of high blood pressure (BP) levels in schoolchildren from the public schools of the city of João Pessoa, state of Paraiba, Brazil, their association with nutritional status and the construction of predictive models that can correlate these two variables.

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## Methods

A cross-sectional study was performed to evaluate the prevalence of high BP in schoolchildren aged 6 to 9 years, of both sexes, attending public Elementary Schools in the city of João Pessoa, capital of the state of Paraíba, Brazil.

To calculate the sample, an expected prevalence of 20.0% was used as parameter to allow the description of the event, if the observed prevalence was higher than the national reference, of around 10.0%[7,8]. A pilot-study carried out with schoolchildren pointed out that the prevalence in João Pessoa might be higher than the national mean. A 95.0% confidence interval was adopted, as well as a precision of three percentage points. Therefore, we arrived at a minimum number of 654[9]. As the participation in the study depended on the agreement by the children and the children's parents to participate in the study, a 20.0% increment was added to the calculated sample size, to make up for possible losses, thus obtaining a sample size of 784 children.

Ten of the 33 neighborhoods of the city were selected by drawing lots; the city had 91 public schools and 47,379 students enrolled in Elementary School. Then, one school was selected at random for each one of these neighborhoods. The 10 schools had a total of 1,735 students at the selected age range that attended the 1st to the 5th year of Elementary School in 2008, according to Technology Board of Information and Communication (TBIC), which is the governmental organ in charge of managing information related to the public school system of João Pessoa.

In order to choose the classes in each selected school, the classes that comprehended the elected age range were included. As the schools were small, students from all classes were selected by the systematic sampling technique, from the schools' students' lists, adopting the criterion of one of every two students, as the total number of children at this age range in all ten schools was a little more than double the sample size.

The data were collected in the first semester of 2008, by a team consisting of nutritionist, a nurse technician and undergraduate students from the Nutrition Course of Universidade Federal da Paraíba, previously trained by the researcher and the nurse tech, with the objective of minimizing errors in measurement acquisitions.

The data were collected in a clinical file that contained data on the individual's identification (name, sex, school year, age), anthropometric measurements (weight, height, abdominal circumference) as well as systolic and diastolic blood pressure. The clinical file was created specifically for that purpose. A pilot study was performed to test and adequate the methodology of data collection.

Each anthropometric measurement was carried out in duplicate and the mean of both measurements was used in the study, according to the techniques recommended by the World Health Organization (WHO)[10] to minimize errors in measurement acquisitions. The weight was measured on a digital scale with a capacity of 150 kg and precision of 100 g, whereas height was measured using a vertical anthropometer with a metal ruler with maximum capacity of 2.04 m and precision of 0.5 cm. The abdominal circumference (AC) was measured with the individual standing, at the end of the expiration, at midpoint between the last costal arch and the anterosuperior iliac crest, using an inelastic measuring tape, in the horizontal position, without compressing the tissues[11].

The body mass index (BMI) was used to evaluate the children's nutritional status, defined as weight in kilograms divided by height in meters squared[10], by age and sex, according to distributions of percentiles and cutoffs proposed by the WHO[12], which considers overweight a BMI ≥ the 85th percentile and < the 97th percentile and as obesity, a BMI ≥ the 97th percentile.

To evaluate abdominal obesity, the abdominal circumference (AC) was measured[11]. Children with AC values ≥ the 90th percentile according to sex and age[13,14] were considered as presenting abdominal obesity, according to the table proposed by the National Center for Health Statistics (NCHS)[15].

The blood pressure (BP) measurement was performed at the school environment, outside the medical office, after the children had been informed about the procedures and the latter had been demonstrated, according to the recommendations in the V Brazilian Guidelines on Arterial Hypertension[5]. The indirect method with auscultation, using a pediatric stethoscope and a previously calibrated aneroid sphygmomanometer, was used to measure the BP, after selecting the adequate cuff according to the arm size. The midpoint of the compressive part of the cuff was placed on the brachial artery and the systolic blood pressure (SBP), as well as the diastolic blood pressure (DBP) were measured. The procedure was repeated two more times, with two-minute intervals between them. The mean value of the three measurements was compared to the reference values from The Fourth Report on the Diagnosis, Evaluation and Treatment of High Blood Pressure in Children and Adolescents of the National High Blood Pressure Education Program (NHBPEP)[16].

High blood pressure was considered in those individuals that presented mean SBP or DBP ≥ the 95th percentile for sex, age and height[16]. The curves of the height percentile per age and sex used in the study followed those proposed by the Centers of Disease Control and Prevention (CDC)[17], as recommended by the 4th NHBPEP report[16].

The exploratory analysis of the data and the description of the results were performed in tables of frequency. The Chi-square test was used to verify association. The prevalence ratio was calculated with the variables that presented a significant association with the blood pressure categories.

Student's t test was used to carry out the comparison of weight, BMI and AC means between the groups with normal BP and high BP. The level of significance was set at 5.0% for all statistical tests.

Three models of logistic regression were created, using as dependent variable the normal and high BP and as independent variable, weight, BMI and AC, respectively. The odds ratio (OR) was obtained, as well as the confidence interval for each one of these models. In all of them, the variables age and sex were included for control.

The data were entered in an Excel spreadsheet and the *SPSS (Statistical Package for the Social Sciences)* software, release 15.0, was used for statistical calculations.

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The study was approved by the Ethics Committee in Research of the Health Science Center of Universidade Federal da Paraíba. All children's parents or tutors signed the Free and Informed Consent Form (FICF), which guaranteed the voluntary characteristic of the individuals' participation. In order to obtain the maximum number of authorizations, several visits to the schools, as well as home visits, were made. Before the data collection, the State Secretary of Education, the school principals and the teachers were advised on the procedures and objectives of the research.

## Results

Of the 784 schoolchildren selected for the study, 750 were evaluated, with a percentage of loss of 4.3% due to the non-return of the FICF by the parents or tutors. Of the 750 evaluated schoolchildren, 53.6% (402) were females and 46.4% (348) were males, with a mean age (± standard deviation) of 7.73 ± 0.9 years. There was a prevalence of 13.6% of children with high BP levels. A smaller percentage of children (8.4%) was considered pre-hypertensive and therefore, presented the risk of developing high BP in the future (Table 1). Considering the SBP, only 3.3% of the children presented high BP levels. A higher percentage of schoolchildren, 11.6%, presented high diastolic BP levels.

There were no significant associations between the variables, age range and sex and the BP classification. The BMI presented a significant association with the BP classification

(p < 0.001). Regarding overweight and obesity, 22.8% and 26.3% of the individuals presented high BP levels, respectively. However, only 10.9% of the individuals with normal weight and 4.3% of the underweight individuals presented BP levels above those recommended for age and height (Table 1). The prevalence ratio of high BP levels among the obese individuals, when compared with those with normal weight, was 2.6.

Table 2 shows the means of weight, BMI and AC with their respective confidence intervals, according to the classification of BP. The Student's t test showed that there was a significant difference between the weight, BMI and AC means, with higher means being observed in children with high BP levels, when compared to those with normal BP levels (weight: p < 0.0001, BMI: p < 0.0001 and AC: p < 0.0001).

Three models were constructed using the logistic regression technique, controlled by the variables age and sex, including the variables weight, BMI and AC, respectively. All of them presented an association with high BP levels, with the following OR: weight, OR = 1.05, 95%CI: 1.03 – 1.08; BMI, OR = 1.17, 95%CI: 1.09 – 1.25 and abdominal circumference, OR = 1.06, 95%CI: 1.03 – 1.09. These results demonstrate that BMI was the best predictor for the risk of high BP in children.

## Discussion

The observed prevalence of high BP levels, 13.6%, was slightly higher than the ones reported in other studies on systemic arterial hypertension in childhood, both national

**Table 1 - Classification of blood pressure (BP) in relation to age range, sex, BMI classification and abdominal circumference (AC) of children from public schools of João Pessoa, PB, Brazil, 2008**

| Variables | BP classification | | | TOTAL n (%) | P * value |
|---|---|---|---|---|---|
| | Normal | Pre-hypertension | High BP | | |
| | n (%) | n (%) | n (%) | | |
| Age range (years) | | | | | |
| 6 | 81 (78.6) | 9 (8.7) | 13 (12.6) | 103 (100.0) | p = 0.616 |
| 7 | 168 (80.4) | 20 (9.6) | 21 (10.0) | 209 (100.0) | |
| 8 | 206 (77.4) | 21 (7.9) | 39 (14.7) | 266 (100.0) | |
| 9 | 130 (75.6) | 13 (7.6) | 29 (16.9) | 172 (100.0) | |
| Sex | | | | | |
| Male | 270 (77.6) | 29 (8.3) | 49 (14.1) | 348 (100.0) | p = 0.938 |
| Female | 315 (78.4) | 34 (8.5) | 53 (13.2) | 402 (100.0) | |
| BMI | | | | | |
| Low-weight | 22 (95.7) | - | 1 (4.3) | 23 (100.0) | p < 0.001 |
| Eutrophic | 460 (81.0) | 46 (8.1) | 62 (10.9) | 568 (100.0) | |
| Overweight | 47 (59.5) | 14 (17.7) | 18 (22.8) | 79 (100.0) | |
| Obesity | 56 (70.0) | 3 (3.8) | 21 (26.3) | 80 (100.0) | |
| AC | | | | | |
| Adequate | 571 (78.0) | 63 (8.6) | 98 (13.4) | 732 (100.0) | p = 0.308 |
| Abdominal obesity | 14 (77.8) | - | 4 (22.2) | 18 (100.0) | |
| Total | 585 (78.0) | 63 (8.4) | 102 (13.6) | 750 (100.0) | |

*BMI - body mass index; AC - abdominal circumference. * Chi-square Test.*

**Table 2 -** Means and 95% confidence intervals (CI) of weight (kg), BMI (kg/m²) and AC (cm), according to the blood pressure (BP) classification of schoolchildren from João Pessoa - PB, Brazil, 2008

| Variables | PA Classification | n (%) | Mean | 95%CI | |
|---|---|---|---|---|---|
| **Weight** | Normal | 648 (86.4) | 26.8 | 26.3 | 27.3 |
| | High BP | 102 (13.6) | 29.5 | 28.2 | 30.8 |
| | Total | 750 (100) | 27.1 | 26.7 | 27.6 |
| **BMI** | Normal | 648 (86.4) | 16.2 | 16.0 | 16.4 |
| | High BP | 102 (13.6) | 17.4 | 16.9 | 18.0 |
| | Total | 750 (100) | 16.4 | 16.2 | 16.5 |
| **AC** | Normal | 648 (86.4) | 56.4 | 55.9 | 56.9 |
| | High BP | 102 (13.6) | 59.4 | 58.0 | 60.8 |
| | Total | 750 (100) | 56.8 | 56.4 | 57.3 |

*BMI - body mass index; AC - abdominal circumference.*

and international ones, which demonstrated a prevalence that ranged from 1.2%-13%[8]. A study carried out in the city of Maceió, state of Alagoas, Brazil, diagnosed 7.7% of hypertensive individuals at the age range of 7-17 years[18]. A similar value was observed in a study of Canadian children, in which hypertension was detected in 7.6% of them[19]. A study carried out in the south of Brazil identified a prevalence of 11.3% in schoolchildren from public schools aged 7-13 years[20]. However, Oliveira et al[21] identified a significantly lower SAH prevalence, of 3.6%, in schoolchildren aged 5-9 years, in Feira de Santana, state of Bahia, Brazil. These variations in the prevalence of AH in the aforementioned studies might be due to the different methodologies used by the studies to measure and diagnose AH in children.

Due to the development of a large database on the BP levels throughout childhood, the capacity to identify children with high BP levels has improved. It is now evident that primary hypertension is detectable in young people and that it occurs commonly. In the long term, the health risks for the hypertensive children and adolescents can be significant[22]. It is important to emphasize that the pre-hypertensive status must be identified and seriously considered, with the objective of establishing strict prevention measures. Although useful as a guide to determine the normal range, the definition of arterial hypertension in children based on percentiles is not used in pediatric clinical practice, which allows mild to moderate cases of AH to go unnoticed[2,22].

According to the 4th Report of NHBPEP[15], children are considered hypertensive when the mean SBP and/or DBP levels are ≥ BP level that corresponds to the 95th percentile, according to sex, age and height of a reference population, in at least three different occasions. As this study was restricted to three BP measurements performed at the same occasion, as several other studies related to the subject, its limitations are acknowledged and the terms "high BP levels or high arterial pressure" were chosen, instead.

A complementary study is suggested to evaluate the persistence of the high BP levels in the children, as well as the association between the high BP levels and the existence of pathologies and sue of medications that can influence blood pressure.

It is also important to emphasize that the comparison of the prevalence results of the assessed variables with those from other studies also becomes complex, due to the diversity of indicators and cutoffs used in the several studies related to the classification of the children's nutritional status. As this is a cross-sectional study, it presents limitations regarding the temporal association between the studied events.

Multiple factors are associated with BP in children and adolescents. Such factors can be determined by genetic or environmental characteristics[22]. Several studies have reported the association between overweight and obesity in childhood with the early onset of cardiovascular risks, such as arterial hypertension. In the present study, the chance of a child having high BP increased in 1.17 for every BMI unit and the isolated weight or AC values presented a lower OR.

In Canada, obesity in children aged 6-13 years was associated with pre-hypertension and hypertension[19]. The study by Nogueira et al[23], evaluating the role of obesity as a risk factor for high BP, demonstrated that the chance of obese children presenting high BP was almost 4-fold higher than that observed in non-obese ones. The child's gender and type of school the child attended, i.e., private or public, were not considered risk factors for high BP.

These studies confirm the increased risk of high BP in obese children and, due to the increasing tendency in the prevalence of childhood obesity reported by several studies[24,25], the prevalence of arterial hypertension can increase among children and adults.

In the present study, as well as in the study by Araujo et al[26], the variables weight, BMI and AC were positively and significantly associated with BP levels. This fact reinforces the importance of measuring these indicators to detect hypertension and future cardiovascular risks.

As described in the literature, the AC is a measurement of central obesity and it is specifically associated with risk factors of cardiovascular diseases, both in adults and children[27,28], which makes it a relevant measurement to evaluate the risk of chronic diseases, such as hypertension. The present study showed a low prevalence of abdominal obesity. However, it is noteworthy the fact that these results, as well as in many

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other studies that evaluated abdominal obesity, used foreign references to assess the abdominal circumference, thus limiting the acquisition of more reliable data that would take into account the local dietary pattern.

As proposed by the WHO, Brazil has been adopting several strategies and actions to reduce the prevalence and the complications of non-transmissible chronic diseases (NTCD) among its population, such as measures against smoking, dietary and nutrition policies and health-promotion measures with emphasis on schools. The country has developed hypertension and diabetes-related healthcare actions, guaranteeing access to free medication programs in the public healthcare system, as well as the implementation of the Family Health Program, as a mandatory strategy in primary healthcare, through the implementation of multiprofessional teams in Basic Health Units that present more favorable conditions to provide access to NTCD management. However, the diagnosis and control actions regarding the NTCD are directed at the adult and elderly population, underestimating the occurrence of these diseases in the pediatric age range[6,29].

According to Lima[30], the identification of children with high BP and its association with risk factors, such as obesity and hyperlipidemia, has brought a new dimension to the preventive measures adopted in childhood and their incorporation to pediatric care, together with the previously established measures, such as immunizations and others, is recommended.

Additional studies are necessary to investigate whether modifications in lifestyle, such as diet improvement and regular practice of physical activity, as recommended by the WHO[31], would normalize the high BP levels observed among the studied children. It is a consensus that this and other measures are potentially successful if implemented as a joint effort made by the family, school, community, society and government, after having them adequate to each population's diversities.

The results of the present work, carried out in the public schools of the city of João Pessoa, state of Paraiba, Brazil, allowed the study of anthropometric indices at a seldom studied age range, allowed the estimate of the prevalence of high BP levels in children aged 6 9 years, which was 13.6% and observed that the variables weight, BMI and AC were associated with BP increase, with BMI being the best model.

The present study concluded that the assessment of the nutritional status and the measurement of BP in childhood are simple and recommended measures for healthcare programs.

The implementation of specific programs and policies to complement the actions currently developed in healthcare services, aiming at the use of approaches directed at parts of population at higher risk and with less access to information would prevent the incidence of chronic diseases in the adult age and decrease public costs with healthcare.

### Potential Conflict of Interest

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

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### Study Association

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