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ORIGINAL ARTICLE

High Blood Pressure in Pre-Adolescents and Adolescents in Petrópolis: Prevalence and Correlation with Overweight and Obesity

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Abstract

Background: Arterial hypertension is a multisystem disease that increases the risk of fatal cardiac events.

Objectives: This study aims to determine the prevalence of increased blood pressure levels of pre-adolescents and adolescents and correlate these pressure levels with the presence of overweight or obesity and family history of hypertension.

Methods: In an observational, cross-sectional study, a sample of 157 students from the city of Petropolis aged from ten to nineteen was randomly selected. The study included four public schools and one private school. The persons responsible for each student answered a questionnaire on pre-existing conditions, family history of hypertension and previous blood pressure measurements. A thorough physical examination, anthropometric evaluation and two blood pressure readings were taken at intervals of at least ten minutes, on three different occasions, totaling six measurements.

Results: Blood pressure levels have shown to be abnormal in 17 (10.8% / IC95% 5.9-15.7) studied individuals. Statistical significance was found between the change in blood pressure and the presence of overweight and obesity ($p < 0.001$), as well as with the presence of family history of hypertension ($p < 0.05$). A portion of 32.5% of the subjects had never had their blood pressure measured, and over the twelve months prior to the study, 45.5% of the sample had not measured it either.

Conclusions: This study demonstrated that a significant percentage of students in the city of Petrópolis, in the state of Rio de Janeiro, has high blood pressure with a statistically significant correlation with overweight or obesity and a family history of hypertension. (Int J Cardiovasc Sci. 2017;30(3):243-250)

Keywords: Hypertension/epidemiology; Adolescent; Child; Obesity; Oveweight; Prevalence.

Introduction

Systemic arterial hypertension (SAH) is a multifactorial clinical condition, characterized by high and sustained blood pressure levels, associated with metabolic and hormonal changes and trophic phenomena (cardiac and vascular hypertrophy). Functional and/or structural changes to target organs (heart, brain, kidneys and blood vessels) and metabolic changes increase the risk of fatal and non-fatal cardiovascular events.[1-4]

In Brazil, SAH affects about 15% to 30% of the adult population.[1,5,6] This high prevalence, combined with the severity of late complications, makes hypertension a priority and a huge public health challenge, since degenerative cardiovascular diseases such as ischemic coronary artery diseases and strokes account for about one third of the mortality of the Brazilian population.[7]

Concern about arterial hypertension in children and adolescents has increased in recent decades. Despite the primary (essential) SAH has relatively low prevalence at this age group compared with adults, at a non-negligible percentage of these individuals, the problem is clinically significant, requiring attention for its early recognition and treatment.[8]

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Traditionally, childhood SAH used to be related to renal, vascular or endocrine disorders, but primary hypertension has become the main identified form and this epidemiological shift has been attributed largely to the recent epidemic of obesity.[9] It has also been found in a longitudinal study that overweight is associated with the maintenance of high percentile of blood pressure and that the disappearance of overweight determined significant reduction in adolescents' blood pressure levels.[2]

Children with higher blood pressure levels, although still within the range considered normal, tend to evolve throughout life with a blood pressure higher than that of the other children and are more likely to become hypertensive adults.[6,10] Thereby, considering that adult SAH may have their origin in childhood, preventive strategies, particularly related to the identification of several cardiovascular risk factors associated with hypertension at this age group should be adopted early in an attempt to reduce late complications of this disease.[8]

This study aims to determine the prevalence of blood pressure changes in a representative sample of the student population, aged from ten to nineteen years, from five major schools of the city of Petrópolis, state of Rio de Janeiro, and correlate their blood pressure levels with the presence of overweight and obesity and family history of hypertension.

Methods

From November 2014 to August 2015, an observational, cross-sectional epidemiological study on a representative, randomly selected sample of the population of pre-adolescents and adolescents aged from ten to nineteen years, who were students at five major schools in the city of Petrópolis/RJ, four public and one private, chosen for convenience.

The sample size calculation took into account estimated average parameters for the prevalence of hypertension at this age group (0.5 to 10%) with 95% confidence interval and error probability of 5%. According to the 2010 IBGE census results,[11] the city had a population of 295,917 people, with 47,772 at the studied age group. The calculations using these parameters indicated that the minimum representative sample of this school population was composed of 138 individuals.

A total of 192 subjects were randomly drawn by principals and teachers, without interference from the researcher. Thirty-five subjects had to be excluded either due to uncomplete data or for not being included in the study age group. The level of participation was therefore 81.34% (157 subjects), of which 85 (54%) were males and 72 (46%) were females. The binomial test, at a significance level $\alpha = 0.05$, indicates no difference between the percentage of boys and girls in the sample ($p = 0.071$). α The Mann-Whitney test, at the same significance level, also indicates no statistically significant age difference between boys and girls ($U = 3.027$; p-value = 0.907).

Ninety-nine participants (63%) attended public schools and 58 (37%) attended private schools.

After obtaining a signed Informed Consent Form, participants' carers answered a self-administered questionnaire, from which complete personal data, family history of Systemic Arterial Hypertension, and previous diseases to each study subject were obtained. It was also asked whether the adolescent had already had his blood pressure checked at least once and over the twelve months preceding the survey.

After having signed a Consent Agreement, each student was examined only by the researcher, on three separate occasions, at intervals longer than 24 hours. On the first occasion, a thorough clinical cardiology examination with assessment of ectoscopy, analysis of peripheral pulses and cardiac auscultation, in addition to anthropometric examination with measurement of weight and height and length and circumference of the right arm. On all three occasions, blood pressure was measured twice, at a minimum rest interval of ten minutes between measurements.

The blood pressure measurement complied with the standards established in the Brazilian Hypertension Guidelines VI – SBC,[1] performed using the indirect method with auscultation and a properly calibrated aneroid sphygmomanometer (Tycos – North Carolina, USA). The equipment was calibrated prior to the beginning of the study and twice more, at intervals of three months. Three sizes of blood pressure cuffs (24 x 12 cm, 18 x 10 cm, and 16 x 8 cm) were also used, from which the one whose inflatable bag width and length were approximate to, respectively, forty percent of the circumference of the right arm and involved its full circumference, was chosen for each individual.[12]

The arithmetic means of the six readings, both systolic and diastolic, were calculated, and the obtained values were plotted in the tables suggested by "The Fourth Report on the diagnoses, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents".[13]

Each participant was finally classified, according to their systolic and diastolic pressure level percentiles, as normotensive, pre-hypertensive, hypertensive and severely hypertensive individuals.

For body weight to be determined, a previously calibrated Kala-branded, 100-gram digital scale, equipped with four sensors and capacity of up to 150 kg was used. Each student was placed barefoot, wearing light clothing, on the middle of the scale, where they remained until the weight in kilograms was measured. Height was measured using a centimeter-scaled ruler, with the participant placed against a wall, barefoot, in a fully upright position and taking a deep breath.

After calculating the body mass index (BMI (m^2) = Weight (kg)/Height^2), each participant was classified according to their nutritional status, in compliance with the 2011 recommendations of the Brazilian Department of Health.[14] The cutoff points used were eutrophics (> 3rd percentile and < 85th percentile), overweight (≥ 85th percentile and ≤ 97th percentile), obesity (> 97th percentile and ≤ 99.9 percentile) and severe obesity (> 99.9 percentile).

This study was approved by the Research Ethics Committee, on September 30, 2014 (CAAE: 31291014.5.0000.5243).

Statistical analysis

Data of categorical variables were summarized by absolute frequencies and percentages, while numerical variable data corresponding to the age of the students were statistically summarized by the mean and standard deviation parameters as mean (± standard deviation).

The Kolmogorov-Smirnov test checked whether the Age variable, alone or stratified into categories, satisfies the normality criterion.

Once unsatisfied the normality criterion, the difference between ages of gender categories was investigated using the Mann-Whitney non-parametric test.

Differences between proportions of categories of dichotomous variables were investigated using the binomial test, while uniformity of the categories of a categorical variable was assessed by using the chi-square test.

The association between categorical variables was investigated using contingency tables and determined by the chi-square test or, in the case of two dichotomous variables, the Fisher's exact test was used. When the investigation of the association between categorical variables resulted in the values expected under the variable independence hypothesis being not very significant (less than 5), the coherent assemblage of categories was adopted in order to densify the frequencies and create conditions so that differences could be evidenced in the analysis. The Cramér V coefficient was used to identify any statistically significant association between polytomous categorical variables.

Population inferences concerning proportional parameters (percentages) or numerical values were performed by means of confidence intervals, at a confidence level of 95%.

Statistical decisions in the hypothesis tests were taken at a level of significance $\alpha = 0.05$ (5%).

Statistical analyses were performed using PASW (SPSS) software, v. 18, by IBM, with the aid of Excel (Microsoft).

Results

The isolated analysis of systolic blood pressure showed that 17 students (10.8%) presented signs of a hypertension status, understood as Pre-SAH or SAH or severe SAH. As to the analysis of diastolic blood pressure alone, 13 students (8.3%) were found to present that status. No student had isolated abnormal diastolic blood pressure.

To determine the prevalence of hypertension, students who have had any change in systolic or diastolic blood pressure (either or both) were considered to be cases. Thus, the assessment of both systolic and diastolic blood pressure identified 17 students (10.8%) with abnormal blood pressure levels. Nine of them (5.7%) had changes in both systolic and diastolic blood pressure, and eight others (5.1%) only in systolic blood pressure (Table 1).

Therefore, the prevalence of hypertension in the studied group (with no distinction as to intensity) was revealed to be 10.8%. Based on this result, the real percentage is estimated to range from 5.9% to 15.7% (Table 2).

Considering that the population of Petrópolis in the age group under study (10-19), according to the 2010 IBGE census,[15] was 47,770 inhabitants, the results achieved with this sample indicate an estimated prevalence of 5,160 individuals in absolute numbers, who would present changes in their systemic blood pressure, and they could, at a 95% confidence, range from 2,840 and 7,479 individuals.

Table 1 – Prevalence of SAH (n = 157)

Blood Pressure		Diastolic blood pressure				Total
		Normal	Pre-hypertension	Hypertension	Severe hypertension	
Systolic Blood Pressure	Normal	140	–	–	–	140
	Pre-hypertension	3	5		–	8
	Hypertension	–	1	2	–	3
	Severe hypertension	1	–	3	2	6
Total		144	6	5	2	157

Table 2 – Estimated percentage of students with impaired BP in the population of Petrópolis/RJ (n = 157)

Systemic Blood Pressure	Number of students	Percentage	Population estimate (I.C. 95%)
Normal	140	89.2	[84.3% ; 94.1%]
Abnormal	17	10.8	[5.9% ; 15.7%]
Total	157	100.0	–

Gender-based pressure change analysis shows that the percentage of male students (76.5%) with abnormal blood pressure exceeded the percentage of female students (23.5%). The difference of 53% between genders is statistically significant (binomial test: p-value = 0.049 < 0.05), which indicates evidence that males are more affected than females in the studied age group, in a 3-to-1 ratio, approximately (Table 3).

There was no statistically significant correlation between increased blood pressure levels and the fact that the students are enrolled in public or private schools (chi-square test: $\chi^2 = 0.464$; g.l. = 1; p-value = 0.601).

A total of 49 students (31.2%) had an increase of Body Mass Index, of which 25 (15.9%) were overweight and 24 (15.3%) were obese. Body Mass Index category to Blood Pressure category ratio shows that Obesity and Severe Hypertension level are moderately inter-related in a direct manner, in a sense that the higher the BMI, the higher the pressure level will be (chi-square test: $\chi^2 = 22.015$; g.l. = 2; $p < 0.0001$). Crámer's V correlation coefficient indicates highly significant, moderate correlation ($p < 0.01$) between blood pressure levels and BMI categories ($V = 0.374$, $p < 0.0001$) and the analysis of adjusted residuals shows the solid contribution of the pair of categories abnormal blood pressure and obesity for the ratio between both variables (adjusted residue equal to 4.6), as well as for normal blood pressure and eutrophic BMI (adjusted residue equal to 3.7). (Table 4)

The large majority of the subjects (81.5%) had a family history of Systemic Arterial Hypertension. The analysis of this positive family history was also associated with statistical significance, with abnormal blood pressure levels (Fisher's exact test: p-value = 0.044 < 0.05).

Approximately one-fourth (27.4%) of the subjects had never had their blood pressure measured, resulting in no statistical correlation of this data with the fact that the student is enrolled in a public or private school. Over the 12 months preceding the study, however, approximately two-fifths (41.4%) of these individuals have not had their blood pressure measured either, with greater and statistically significant prevalence among private school students (chi-square test: $\chi^2 = 4.075$; g.l. = 1; p-value = 0.046).

Table 3 – Gender-based analysis of the BP categories (n = 157)

Systemic blood pressure	Total number of students	Gender			
		Male		Female	
		n	%	N	%
Abnormal	17	13	18.1 CI (95%): 9.2% ; 27.0%	4	4.7 CI (95%): 0.2%; 9.2%
Normal	140	59	81.9 CI (95%): 73.0% ; 90.8%	81	95.3 CI (95%): 90.8% ; 99.8%
Total	157	72	100.0	85	100.0

Table 4 – Correlation between high blood pressure levels and abnormal BMI (n = 157)

Presence of abnormal blood pressure		Body mass index			Total
		Eutrophic	Overweight	Obesity	
Normal	N	103	22	15	140
	Adjusted residue	3.7	-0.2	-4.6	
Abnormal	N	5	3	9	17
	Adjusted residue	-3.7	0.2	4.6	
Total		108	25	24	157

Discussion

The prevalence of hypertension in childhood and adolescence, reported by several Brazilian and foreign authors, varies widely, from 1.2% to 13%, depending largely on the methodology adopted, study age group, number of measurements at each visit, number of visits and total follow-up time.[6,11,16] This study identified abnormality in blood pressures, regardless of their severity, in 10.8% of the student population (95% CI 5.9 to 15.7). Similar values were found in Brazilian studies, such as the one by Moura et al.,[17] in the city of Maceió, (9.41%, 95% CI 7.8 to 11.02). Magliano et al.[18] identified a prevalence of 8.12% (95% CI 6.24 to 10.52%) using meta-analysis. Another cross-sectional study by Correa Neto et al.[19] with subjects aged 17-19 years, in the city of Rio de Janeiro, identified a higher prevalence of 19.4% of changes in blood pressure with a statistically significant correlation with the presence of overweight and obesity. Recently, Bloch et al.,[20] when carrying out a broad, countrywide study, showed that 9.6% (95% CI 9.0 to 10.3) of Brazilian adolescents attending schools in cities with more than 100,000 inhabitants have high blood pressure (pre-hypertension or hypertension) with higher prevalence among males[21].

There are several environmental factors related to the development of hypertension. Among them, weight and BMI are recognized as the major determinants of high blood pressure levels in children and adolescents, with tremendous growth of the prevalence of severe obesity in this age group in the past decade.[8,21-23] A recent study conducted in England by Skinner et al.,[24] covering 8,579 overweight or obese children and adolescents, showed that the greater the severity of obesity, the higher the systolic and diastolic blood pressure of these patients. Parker et al,[25] also found a statistically significant association between increased BMI and development of high blood pressure in a study involving 101,606 individuals, aged from three to seventeen years old, in the United States of

America. This same study found that obese children and adolescents had twice the risk of developing hypertension when compared to subjects with normal weight, and those diagnosed with severe obesity had a risk four times higher. Flechtner-Mors et al.[26] identified 22% prevalence of SAH and 8% prevalence of pre-hypertension in European overweight or obese children and adolescents. In Brazil, a study by Rosaneli et al.[10] on schoolchildren aged 6 to 11 years old, in the city of Maringá, identified 11.2% prevalence of pressure changes in eutrophic children, 20.6% in overweight children and 39.7% in obese children.

There was no statistically significant difference between changes in BMI (overweight or obesity) and administrative educational categories. The correlation between the data on High Blood Pressure and abnormal Body Mass Index shows that Obesity and abnormal high blood pressure are directly interrelated, in a sense that the higher the BMI, the higher the pressure level will be. Among the individuals identified as having abnormal blood pressure, 70% also had BMI changes, of which 17% are overweight and 53% are obese.

In adults, SAH is unarguably one of the most important risk factors for the development of cardiovascular diseases, particularly the coronary artery disease.[27] It is recognized that the disease, in its primary form, may begin early in life and that genetic factors play a decisive role in its development. Thus, the existence of a family history of SAH was shown to significantly affect the emergence of this condition in children.[28]

In this study the presence of hypertension in at least one individual (grandparents, parents or siblings) was considered a positive family history. The large majority of adolescents (82.2%) had positive family history, and all those (100%) with abnormal blood pressure also had a positive family history, demonstrating once again the importance of this factor in the development of cardiovascular diseases.

Although the measurement of children's and adolescents' blood pressure is recommended in all clinical evaluation after three years or in special risk situations before this age, this is not a habit in pediatric consultation, resulting in many hypertensive patients being undiagnosed. These data indicate the need for educational actions involving health professionals, providing not only scientific information but also technical conditions for a wider and safe approach to the cardiovascular system of these patients. Considering that the hypertension diagnosis is made after confirmation of the presence of persistently high blood pressure, it is important to emphasize the need for routine blood pressure measurements. Studies such as those by Negroni-Balasquide et al.,[29] observed a drop in blood pressure levels between the first and third measurements, indicating the possibility of misdiagnoses from single or sporadic measurements.

A more intensive approach to health managers and professionals in the diagnosis of hypertension in childhood and adolescence and a prophylactic approach, such as the control of overweight and obesity and the encouragement of regular physical exercise, can determine a significant decrease in the number of hypertensive adults, with lower rates of morbidity and mortality, also generating significant reduction in high costs to public health.

This study had as limiting factors the choice of participating schools for convenience, which does not allow to state that the sample is representative of the entire population of the city of Petrópolis, aged 10-19 years old.

Conclusion

We conclude that a non-negligible percentage of pre-adolescents and adolescents, from five major schools of the city of Petrópolis/RJ, have high blood pressure, which is more frequent in males, in 3:1 ratio, with no statistically significant relationship with the administrative educational categories.

Statistical significance was found between the change in blood pressure and the presence of overweight and obesity ($p < 0.001$), in the sense that the higher the BMI, the higher the blood pressure is. Family history of hypertension was identified in all adolescents with abnormal blood pressure levels.

A significant number of the studied adolescents had never had their blood pressure measured. This fact determines a delay in the identification and treatment of these patients, when indicated.

Author contributions

Conception and design of the research: Figueirinha F. Acquisition of data: Figueirinha F. Analysis and interpretation of the data: Figueirinha F. Statistical analysis: Figueirinha F. Writing of the manuscript:

Figueirinha F. Critical revision of the manuscript for intellectual content: Figueirinha F, Haddad Herdy GVH. Supervisor / Principal Investigator: Figueirinha F.

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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