









High levels of blood pressure among Brazilian overweight and obese children and adolescents

Níveis altos de pressão arterial elevada entre crianças e adolescentes brasileiros portadores de sobrepeso e obesidade

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ABSTRACT

Background: Arterial hypertension (AH) is a growing problem globally, bringing various health consequences. Numerous surveys show that the risk of AH is higher in overweight and obese individuals than in eutrophic ones. However, the number of data that investigates blood pressure in obese pediatric populations is still small. Therefore, this study aims to assess the prevalence of hypertension in overweight and obese children and adolescents. **Methods:** Retrospective cross-sectional study with children and adolescents from two health services in different regions of Brazil and distinct socioeconomic profiles. All children and adolescents seen between 1998-2020, aged 5-17 years, with a body mass index greater than +1 standard deviation (Z-score), were enrolled in the study. Blood pressure was measured once with the patient lying down and at rest. American Academy of Pediatrics guidelines were used to classify the patient's blood pressure levels. **Results:** 691 patients were evaluated (49% male). Of these, 47.6% had hypertension. The prevalences of hypertension among overweight and obese subjects were 38.8% and 51.5% ($p = 0.002$), respectively. In addition, obese people were 1.67 times more likely to have hypertension than overweight people. Males had a higher prevalence of hypertension (52.1% vs. 43.3%; $p = 0.002$) and were 1.3 times more likely to have high blood pressure values. **Conclusion:** The prevalence of hypertension was high in overweight and obese children and adolescents from two pediatric outpatient clinics. Males and subjects with obesity were at significantly higher risk of having hypertension.

Keywords: Hypertension, Arterial pressure, Obesity, Overweight, Child Health.

RESUMO

Introdução: A hipertensão arterial (AH) é um problema crescente no mundo e traz várias consequências para a saúde. Numerosos levantamentos mostram que o risco de AH é maior em indivíduos com sobrepeso e obesos do que nos eutróficos. Por isso, este estudo tem como objetivo avaliar a prevalência de hipertensão arterial em crianças e adolescentes portadores de sobrepeso e obesidade. **Métodos:** Estudo transversal retrospectivo com crianças e adolescentes de dois serviços de saúde em diferentes regiões do Brasil e perfis socioeconômicos distintos. Todas as crianças e adolescentes atendidos entre 1998 e 2020, com idades entre 5 e 17 anos, com escore z de índice de massa corporal superior a +1 foram incluídos no estudo. A pressão arterial foi medida uma vez com o paciente deitado e em repouso. As diretrizes da Academia Americana de Pediatria foram usadas para classificar os níveis de pressão arterial do paciente. **Resultados:** Foram avaliados 691 pacientes (49% do sexo masculino). As prevalências de hipertensão arterial entre indivíduos com sobrepeso e obesidade foram de 38,8% e 51,5% ($p = 0,002$), respectivamente. Além disso, os indivíduos obesos tinham 1,67 vezes mais chances de ter hipertensão em comparação com os portadores de sobrepeso. Os homens apresentaram maior prevalência de hipertensão arterial (52,1% vs. 43,3%; $p = 0,002$) e foram 1,3 vezes mais propensos a ter valores mais elevados de pressão arterial. **Conclusão:** A prevalência de hipertensão arterial em dois ambulatórios pediátricos foi elevada entre crianças e adolescentes portadores de sobrepeso e obesidade. Homens e indivíduos com obesidade tiveram risco significativamente maior de hipertensão. **Palavras-chave:** Hipertensão, Pressão arterial, Obesidade, Excesso de peso, Saúde da criança.

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INTRODUCTION

For adults, high blood pressure (HBP) is one of the most important risk factors for the development of cardiovascular and renal diseases¹. The World Health Organization (WHO) estimates that one in three adults suffer from hypertension². Among children, the estimate of arterial hypertension varies around 2.2%³. Data from 2008 showed that 40% of the world's adult population had AH, with 1 billion cases without adequate control and an annual increase of 400 million cases since 1980, leading to 9.4 million deaths per year⁴.

Obesity results from complex interactions of genetic, environmental, and behavioral factors, which act in regulating the body's energy balance⁵, and is currently one of the world's biggest public health problems. In the US, it is estimated that about 6% of adolescents are severely obese⁶ and the prevalence has tripled in the infant and youth population since 1980⁷. A systematic review by Heinz et al., among Brazilian children, showed a prevalence of excess weight ranging from 0.9% to 35.4%, according to the geographic region of the country⁸. It is known that being overweight is accompanied by several morbidities, such as diabetes, cardiovascular, and orthopedic disorders, including arterial hypertension (AH)⁸. Studies conducted in the pediatric population have shown that the prevalence of AH is higher in overweight and obese groups than among eutrophic⁹⁻¹¹. The 7th Brazilian Guideline on Hypertension¹², published in 2016, suggests that the number of children and adolescents diagnosed with AH has doubled since 1996.

AH may be secondary to kidney, endocrine and vascular diseases^{13,14}; however, it is believed that 75% of the incidence is related to obesity⁴ and that it is one of the most prevalent changes among obese⁴, often considered as the comorbidity that imposes on the patient the greatest risks to his/her health¹⁵. Data from the *Framingham Heart Study*, referring to adults, showed a relative risk for developing AH of 1.48 and 1.70 for overweight in men and women and 2.23 and 2.63 for obese men and women, respectively¹⁶. In the pediatric age group, a recent National Sampling Indian study showed a prevalence of 23% systolic or diastolic AH among apparently healthy children aged 5 to 15 years¹⁷. In China, in children aged 6 to 13 years, the prevalence of AH in a 2015 national study was 18.4%¹⁸ and, in Japan, 15.9%¹⁹. In all these studies, AH was more associated with overweight children and

adolescents. A study by Fuly et al. showed that the risk for AH among overweight children was 2.9 times higher compared to eutrophic children²⁰. In Brazil, a study conducted with 647 adolescents found that the prevalence of high BP among those with average weight was 8.6%, but among those with excess weight, the number increased to 27.5%²¹.

Adipose tissue plays a key role in the genesis of hypertension²² and one of the mechanisms that explains this relationship is the higher production of pro-inflammatory adipocytokines in obese individuals, resulting in a chronic inflammatory state²³. The adipose tissue of obese patients produces leptin, TNF-alpha, resistin and interleukin-6, in addition to reactive oxygen species, favoring endothelial dysfunction⁴, in addition to producing reduced amounts of adiponectin²⁴. In the kidneys, obesity increases natriuresis and, consequently, sodium resorption, as it activates the renin-angiotensin system, besides altering the dynamics of forces within the renal parenchyma. Abnormally high concentrations of renin, angiotensinogen, angiotensin II and aldosterone have been demonstrated in obese patients, despite the volume expansion and sodium retention observed in these subjects²⁴. Changes in the renal structure are also observed in chronic cases, leading to functional impairments in the nephron that culminate in hypertension²⁵. Obesity increases the activity of the sympathetic nervous system through hyperstimulation of peripheral α 1 and β -adrenergic receptors¹¹. The free fatty acids produced in the obese's diet increase the α -adrenergic sensitivity of the vessels leading to their hypertonia. Additionally, the sensitivity of baroreceptors is impaired in obesity¹¹. Insulin resistance, common in most obese patients, reduces the production of nitric oxide, which has a vasodilator effect²⁴. In obese children with increased blood pressure, an increase in the thickness of the intima layer of the arteries is already observed, demonstrating the beginning of the atherosclerotic process²⁶.

Blood pressure data in obese children and adolescents are less published than those related to other comorbidities. This fact is possibly due to the greater complexity of measuring blood pressure levels in this population, requiring frequent cuff replacement and greater difficulty for auscultation of noise due to thick adipose panniculus²⁷. The present study aims to show the prevalence of AH in a group of overweight and obese children and adolescents followed in two outpatient services.

METHODS

This is a retrospective cross-sectional study using convenience sampling; data collection was carried out using two health services in different regions of the country and different socioeconomic profiles. Inclusion criteria were: all patients seen between 1998 and 2020, of both genders, aged between 5 and 17 years and with body mass index (BMI) above z score +1 (overweight between +1 and +2 and obesity above +2), who had complete data on age, sex, weight, height and BP (n= 1296). Exclusion criteria were: unrecorded height measurement (n=62), missing or incomplete BP data (n=421) and/or presence of other diseases such as body deformities, neuro-psychomotor development delay, autism spectrum disorder, genetic syndromes, ADHD, type 1 diabetes mellitus, inborn errors of metabolism and hypothyroidism (n=122). In compliance with the above criteria, the evaluated patients were distributed as follows: setting 1: clinic specialized in nutritional diseases in Ribeirão Preto, SP, which serves patients with health insurance (n = 238); setting 2: patients from the public health system of the obesity reference outpatient clinic of the Hospital de Clínicas de Porto Alegre (n = 453). In total, 691 patients were evaluated.

The anthropometric assessment followed a standardized technique, according to WHO recommendations²⁸, and all patients did it during the first visit. In the medical record, some patients had only the BMI recorded, and it was impossible to know their height, which is a fundamental measure for comparing BP with cutoff points (n=62)²⁹. BP was measured once, with the patient lying down, at the end of the physical examination, which allowed a period of relaxation prior to the measurement. The cutoff points for BP classification were based on an American Academy of Pediatrics (AAP) document³⁰ and divided into four BP groups: normal, high, stage 1 AH and stage 2 AH. The classification was performed using an online calculator provided by AAP²⁹. Although the measurements

were performed only once, without prior rigorous rest and predetermined time, for the purposes of nomenclature, in the present study, we chose to name Arterial Hypertension (AH) whenever the values were above the cutoff points, even recognizing that, from an individual point of view, for this diagnosis to be confirmed, stricter measurement criteria are needed.

The results were evaluated according to prevalence data and through studies comparing prevalences according to gender (male and female), age group (preschool aged between ≥ 5 and < 7 years; schoolchildren aged between ≥ 5 and < 7 years old; ≥ 7 and < 10 years; adolescent aged ≥ 10 to < 18 years) and degrees of overweight (overweight and obesity). Statistical analyses were performed with GraphPad Prism software³¹, using Fisher's exact and Odds Ratio tests with a 95% confidence interval.

The study was approved by the ethics committees of the Federal University of São Carlos (number 4,133,407) and the Hospital de Clínicas de Porto Alegre (number 07/258).

RESULTS

Among the 691 patients examined, 329 (49%) were boys, 362 (52.4%) had normal BP, and 329 (47.6%) had AH, including the high, stage 1 and stage 2 categories. The prevalence of AH in overweight and obese individuals was 38.8% and 51.5%, respectively (Table 1). Statistical analysis revealed a significant difference in the prevalence of AH between overweight and obese individuals ($p=0.0022$), with obese patients being 1.675 times more likely to have AH than overweight patients. Regarding gender, AH was more prevalent in males (52.1%) than females (43.4%), with this difference being statistically significant ($p=0.0224$). Additionally, male patients were about 30% more likely to develop AH than females. There was no difference in the prevalence of AH according to age group.

Table 1

Distribution of individuals according to gender, nutritional status and blood pressure classification

	Normal BP	Altered BP	High BP	AH stage 1	AH stage 2
Total (N = 691, 100%)	362 (52.4%)	329 (47.6%)	81 (11.7%)	167 (24.2%)	81 (11.7%)
Preschool children (n = 59, 100%)	29 (49.2%)	30 (50.8%)	13 (22%)	11 (18.6%)	6 (10.2%)

	Normal BP	Altered BP	High BP	AH stage 1	AH stage 2
School children (n = 189, 100%)	111 (58.7%)	78 (41.3%)	20 (10.6%)	42 (22.2%)	16 (8.5%)
Adolescent (n = 443, 100%)	222 (50.1%)	221 (49.9%)	48 (10.8%)	114 (25.7%)	59 (13.3%)
Chi-square: 4.215 (p=0.1216)					
Male sex (n = 340, 100%)	163 (47.9%)	177 (52.1%)	42 (12.3%)	85 (25%)	50 (14.7%)
Female sex (n = 351, 100%)	199 (56.7%)	152 (43.3%)	39 (11.1%)	82 (23.3%)	31 (8.9%)
OR: 1.300 (p=0.0224)					
Overweight (n = 209, 100%)	128 (61.2%)	81 (38.8%)	22 (10.5%)	44 (21%)	15 (7.2%)
Obesity (n = 482, 100%)	234 (48.5%)	248 (51.5%)	59 (12.2%)	123 (25.5%)	66 (13.7%)
OR: 1.675 (p=0.0022)					

BP: blood pressure

AH: Hypertension

OR: Odds ratio

DISCUSSION

Obesity in childhood is related to several predisposing and aggravating factors, whether in the family environment or the social context, among which the time and sleep conditions, physical activities, leisure, sedentary lifestyle, eating habits and diet quality can be highlighted, as well as the social relationships established between people. The interaction between these factors can also contribute to the emergence of complications of obesity, including arterial hypertension³²⁻³⁴.

The present study showed that there is a higher prevalence of AH among boys and obese people when compared to overweight individuals, which has also been verified by other authors. The Brazilian study ERICA (Study of Cardiovascular Risks in Adolescents), a nationwide for schoolchildren aged between 12 and 17 years, showed a prevalence of pre-hypertension and AH of 14.5% and 9.6%, respectively, higher among boys and older³⁵. In an Argentine study³⁶, 5,936 children and adolescents from private and public schools were evaluated, and a significant association (p<0.001) between males and AH was found, as well as between BMI and BP. In the present study, there were no differences regarding the three age groups evaluated. Ferreira et al.¹⁴ evaluated 129 obese patients aged between 7 and 14 years in the state of Mato Grosso and found 15.8% of hypertension among boys and 26.4% among girls, with the highest prevalence in the age group

between 13 and 14 years old. Rosaneli et al.³⁷, in a study that evaluated 4,609 children aged between 6 and 11 years from public schools in Maringá and found a 14.4% prevalence of AH. In China, a national sample study with children aged between 6 and 13 years showed a prevalence of AH of 20.2% for boys and 16.3% for girls¹⁸. A Brazilian study by Fuly et al. found no difference between genders²⁰. Data from the Brazilian Institute of Geography and Statistics for the years 1998 (196,439 individuals), 2003 (231,921 individuals), and 2008 (250,664 individuals), analyzing only adults, show a higher prevalence of AH among women, especially those with low income³⁸. However, data from WHO suggest that the prevalence of AH is higher in men², which is accordingly to our results.

The present study evaluated only overweight and obese children and adolescents, so it was not possible to make comparisons with eutrophic patients. However, a previous study made by our group already showed that AH was more prevalent in obese children aged between 7 and 11 years old when compared to eutrophic women of the same age group⁹. In this study, the observed prevalence of AH was 47.6%. The ERICA study observed an increasing trend in the prevalence of AH with the increase in BMI, and the authors considered that 17.8% of the prevalence could be attributed to obesity³⁴. In that same study, the prevalence among obese people was 8.4% and among overweight people was 17.1%, totaling 25.5%³⁴, results similar Silva et al. (27,5%)²¹

and Ferreira et al. (21,7%)¹⁴, but much lower than those from the present study. However, it should be taken that the age groups are not similar, considering that our study included not only adolescents but also schoolchildren. In fact, data from Rosaneli et al.³⁷, which studied children aged between 6 and 11 years, showed a prevalence of 20.6% among those who were overweight and 39.7% among those who were obese (39.7%). The results of the present study, as well as of Rosaneli et al.³⁷, may indicate that obesity-related hypertension is also a relevant problem in younger children.

It is also possible that the use of different criteria may influence the prevalence data. Thus, if only those individuals effectively classified as hypertensive in stages 1 (24.2%) or stage 2 (11.7%) were considered, the prevalence would become closer (35.9%) to the other cited studies. Anyway, the higher prevalence of AH observed in our study can be explained by the fact that we studied children and adolescents treated in specialized clinics, to which patients with more severe conditions of these nutritional disorders are referred. Thus, the population studied cannot be considered representative of their respective communities.

An additional limitation resides in the fact that we did not include eutrophic individuals, which may influence the comparison of some data found, as well as the conclusions. We did not record blood pressure in a sitting position, and it would be an important additional information since postural variation in blood pressure is equally important in assessing hypertension. A single blood pressure recording may not translate into individual clinical information, and the data shown must be interpreted as epidemiological information. Finally, another limitation is the fact that the diagnosis of AH was based on the measurement of blood pressure in just one opportunity and without strict rest, which may have led to an increase in the prevalence since, to confirm the change, measurements must have been made in at least three separate occasions¹².

In conclusion, the data from the present study show that AH is quite prevalent among overweight children and adolescents, especially among boys. Additionally, the higher prevalence in patients with obesity when compared to those with overweight showed that the worsening of obesity tends to increase the prevalence. AH prevention and control measures must take these data into account so that

they can be more effective. Also, the responsibility of seeking the diagnoses of obesity and AH is up to professionals, especially the ones who care for children and adolescents, so that patients with these conditions can be properly treated.

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