

Risk Factors Associated with High Blood Pressure in Two- to Five-Year-Old Children

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Abstract

Background: Over recent decades, the prevalence of high blood pressure (BP) has increased among children. Several risk factors are involved in the genesis of high BP during childhood, and their early identification can prevent the development of that disease.

Objectives: To assess the prevalence of high BP and associated factors in children.

Methods: Cross-sectional, population-based study, carried out at the household. This study included 276 two- to five-year-old children in the city of Goiânia, state of Goiás, and assessed their BP, sociodemographic characteristics, birth weight, high BP family history, passive smoking, maternal breastfeeding, dietary habits, sedentary lifestyle and nutritional status. Poisson regression was used to assess the association between risk factors and high BP.

Results: Their mean age was 3.1 ± 0.79 years, and high BP and overweight were observed in 19.9% and 11.2% of the children, respectively. Direct association of high BP was identified with age [prevalence ratio (PR) = 2.3; 95%CI: 1.2 – 4.8; $p = 0.017$] and overweight (PR = 2.0; 95%CI: 1.2 – 3.6; $p = 0.014$). No other variable associated with high BP.

Conclusions: The prevalence of high BP in children was high. Overweight and younger children had greater prevalence of high BP. (Arq Bras Cardiol. 2014; 102(1):39-46)

Keywords: Risk factors; Blood pressure; High blood pressure; Children; Preschoolers.

Introduction

Cardiovascular diseases (CVDs) are the major cause of disability and early death worldwide¹. Systemic arterial hypertension (SAH) is one of the most important risk factors for the development of CVDs¹.

Over recent decades, the prevalence of high blood pressure (BP) has increased among children, and failure to diagnose it can lead to no treatment and illness persistence until adulthood². The presence of high BP in children can anticipate the onset of lesions in target organs, such as left ventricle hypertrophy, increased thickness of the carotid arteries, retinal vascular changes, and even subtle cognitive changes³⁻⁵.

Several factors can be associated with the development of high BP in children. A classic study, the Bogalusa Heart Study, has demonstrated that hereditary factors, overweight and low birth weight significantly influence the development of high BP levels in that age group⁶⁻⁸. Other

possible risk factors are sedentary lifestyle, low-quality food, lack of maternal breastfeeding (MB), and the smoking habit of parents or caregivers⁹⁻¹².

In recent years, national¹³⁻¹⁵ and international^{16,17} studies on SAH have been conducted in children and adolescents, but BP of preschoolers is yet unsatisfactorily investigated.

Considering the high prevalence of high BP among preschoolers and the scarcity of Brazilian research about BP behavior in that age group, this study aimed at assessing the prevalence of high BP in preschoolers, and at investigating the factors associated with BP elevation in children under the age of five years.

Methods

This is a cross-sectional, population-based study, carried out at the household and inserted in the matrix project “Nutritional Profile of Children Under the Age of Five in the City of Goiânia”. The households were selected by use of cluster sampling in multiple stages: random drawing of census sectors (CS), household, and participant child. In the first stage, a random drawing of 87 CS among 1,063 CS was performed. The second stage consisted of the random drawing of the participant household. In each CS, data collection initiated at the block with the highest left corner in the map; then, in the clockwise direction, the first and third households were visited. The third stage consisted of the pre-established random drawing of the participant child, if there was more than one child under the age of five in the household.

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The matrix study included children aged up to four years, 11 months and 29 days living in the urban area of the city of Goiânia. Children with the following characteristics were excluded: institutionalized; hospitalized; physically and/or mentally disabled, who made anthropometric data collection difficult; and those on enteral or parenteral nutrition.

This study investigated 835 children, of whom, 470 aged from two years to four years, 11 months and 29 days were eligible for the study. Of those 470 eligible children, 110 (23.4%) refused to undergo BP measurement, six (1.3%) refused to undergo anthropometric measurements, and the cuff was too big for the arm circumference of 69 (14.7%) children. It is worth noting that nine (1.9%) children were excluded from the study because, due to their BP levels, they were considered outliers¹⁸.

With those losses and exclusions, 276 children were assessed in this study. A calculation demonstrated that such sample allowed the detection of high BP prevalence with a 4.8% absolute error, considering the high BP prevalence in children as 22.1%¹⁹.

Data were collected from September 2011 to October 2012, by applying a standard questionnaire to the mothers or guardians, by undergraduate or post-graduate students properly trained for that task and taking the anthropometric and BP measures. The following sociodemographic variables were assessed: sex; age; and mother's educational level and socioeconomic class. Age was presented in complete years (two, three and four years). The mother's educational level was presented as complete schooling years and distributed as follows: < nine schooling years and \geq nine schooling years.

The socioeconomic class was assessed by use of the questionnaire about consumer goods and educational level²⁰. After the classification, the classes were grouped and categorized as follows: A and B, score \geq 17 points; C, score between 11 and 16 points; and D and E, score from 0 to 10 points.

The following health variables were assessed: birth weight; family history of SAH (parents and grandparents); passive smoking; and duration of exclusive MB. Low birth weight was defined as that \leq 2,500 g, and the information was collected from the child's health records²¹. A family history of SAH was considered positive when SAH was reported in children's parents or grandparents. Passive smoking was categorized as positive when the child's father, mother or caregiver had that habit²². Exclusive maternal breastfeeding was categorized as follows: \geq four months and < four months.

The lifestyle variables considered were dietary habits and sedentary lifestyle. A questionnaire about dietary ingestion, validated for children aged from two to five years²³, was applied to assess the regular ingestion of food considered markers of a healthy diet (vegetables, fruits, milk and derivatives) and markers of an unhealthy diet (charcuterie, cookies, sodas and candies). The ingestion was considered regular when occurring five or more days per week²⁴. The cutoff point of a sedentary lifestyle corresponded to watching TV for more than two hours per day²⁵.

The following children's measures were taken: weight, height, and BP level. The children wearing light clothes were weighted on a G-Tech® digital scale, with maximum

capacity of 150 kg and accuracy of 100 g. Height was measured with a flexible and unextendable measuring tape (0.1-cm accuracy) fixed to the wall, and with the help of a wooden set-square²⁶.

The body mass index/age (BMI/age) was calculated based on weight and height measures. The nutritional status was categorized as follows: slimness, z score < -2; eutrophy, z score \geq -2 and \leq + 1; at risk for overweight, z score > + 1 and \leq + 2; and overweight, z score > + 2²⁷.

Blood pressure was measured by using a semiautomatic device (OMRON-HEM 705 CP) and a 9-cm arm cuff. Blood pressure was measured twice on the left arm and in the sitting position, with a five-minute rest before the first measurement and a two-minute interval between measurements, according to the 4th Task Force recommendations²⁸. The first measure was discarded, and the second one was considered for the statistical analyses.

Blood pressure was categorized as follows: no high BP, corresponding to systolic BP (SBP) and diastolic BP (DBP) values below the 95th percentile; and high BP, SBP and/or DBP values equal to or above the 95th percentile, considering children's sex, age and height²⁸. The MedCalc 3000 software was used to classify BP.

The database was built with the Epi Info™ software, version 3.5.2, with double entry to assess typing consistency. The statistical analyses were performed by using the Stata/SE software, version 12.0. The variable BP was adopted as the outcome variable. Association analyses between independent variables and the outcome variable were performed by using Pearson chi-square test. To identify the factors associated with high BP, Poisson regression was used in models adjusted by the variables that showed significance lower than 20% ($p < 0.20$) on bivariate analysis. The magnitude of the association between the risk factors and the outcome variable occurrence was expressed as prevalence ratio (PR) and respective confidence intervals (95%CI). The significance level adopted was $p < 0.05$.

This study was approved by the Ethics Committee of the Federal University of Goiás (UFG 078/2011) and the parents/guardians authorized the participation of the children in this research by signing the written informed consent.

Results

This study assessed 276 children, 145 of whom (52.5%) were males. The mean values of the children's variables were as follows: age, 3.1 ± 0.79 years; BMI, 16.3 ± 2.1 kg/m²; SBP, 95.0 ± 11.0 mm Hg; and DBP, 60.4 ± 10.7 mm Hg. Table 1 shows the sociodemographic characteristics of the sample studied. Most of the mothers of the children assessed had more than nine schooling years (71.4%) and belonged to C economic class (54.3%). Low birth weight was observed in 7.2% of the children, and the prevalence of exclusive MB for more than four months was observed in 44.6% of the sample. Family history of SAH was present in 69.9% of the families, and either the fathers or the mothers or the caregivers of 27.1% of the children were smokers. The prevalence of high BP was 19.9%, and that of overweight, 11.2%.

Table 1 - Sample distribution and high blood pressure prevalence according to sociodemographic, health and anthropometric characteristics, and lifestyle of two- to five-year-old children in the city of Goiânia, state of Goiás, Brazil, 2012. (n = 276)

Variables	Sample distribution n (%)	High blood pressure n (%)	p*
Sex			
Male	145 (52.5)	28 (19.3)	0.787
Female	131 (47.5)	27 (20.6)	
Age (years)			
2	77 (28.0)	23 (29.9)	0.007
3	105 (38.0)	22 (21.0)	
4	94 (34.0)	10 (10.6)	
Mother's educational level (schooling years)			
< 9	79 (28.6)	13 (16.5)	0.361
≥ 9	197 (71.4)	42 (21.3)	
Economic class			
A/B	93 (33.7)	18 (19.3)	0.935
C	150 (54.3)	31 (20.7)	
D/E	33 (12.0)	6 (18.2)	
Birth weight¹			
< 2,500 g	20 (7.2)	5 (15.0)	0.567
≥ 2,500 g	253 (92.8)	49 (20.3)	
Family history of SAH (parents and grandparents)²			
Yes	185 (69.0)	37 (20.0)	0.928
No	83 (31.0)	17 (20.5)	
Passive smoking³			
Yes	72 (27.1)	10 (13.9)	0.113
No	194 (72.9)	44 (22.7)	
Exclusive MB for ≥ 4 months⁴ (months)			
Yes	121 (44.6)	21 (17.4)	0.412
No	150 (55.4)	32 (21.3)	
TV time (hours)			
< 2h	141 (51.0)	30 (21.3)	0.566
≥ 2h	135 (48.9)	25 (18.5)	
Nutritional status			
Slimness/ Eutrophy	196 (71.0)	33 (16.8)	0.048
At risk for overweight	49 (17.8)	11 (22.4)	
Overweight	31 (11.2)	11 (35.5)	

¹n = 273; ²n = 271, ³n = 266, ⁴n = 248; *Pearson chi-square test; SAH: systemic arterial hypertension; MB: Maternal breastfeeding.

Regarding food consumption, most children had regularly a healthy diet, which included vegetables (87.0%), fruits (84.8%) and milk (96%). However, they also ate regularly unhealthy food, mainly sodas (33.7% of the children) (Table 2).

The bivariate analysis showed that age ($p = 0.003$) and overweight ($p = 0.010$) correlated directly with high BP, while the regular intake of milk and derivatives showed an inverse association with high BP ($p = 0.031$) (Tables 1

and 2). The following variables showed no association with high BP: child's sex; mother's educational level; mother's socioeconomic class; birth weight; family history of SAH; MB; regular intake of vegetables, fruits, sodas, candies and charcuterie; time in front of the TV; and passive smoking.

On the analysis adjusted by age, intake of milk and derivatives, intake of charcuterie, passive smoking, and nutritional status ($p < 0.20$ on raw analysis), the association

Table 2 - Sample distribution and high blood pressure prevalence according to food consumption of two- to five-year-old children in the city of Goiânia, state of Goiás, Brazil, 2012. (n = 276)

Variables	Sample distribution n (%)	High blood pressure n (%)	p*
Food ingestion more than 5x/week			
Vegetables			
Yes	240 (87.0)	46 (19.2)	0.414
No	36 (13.0)	9 (25.0)	
Fruits			
Yes	234 (84.8)	48 (20.5)	0.566
No	42 (15.2)	7 (16.7)	
Milk and derivatives			
Yes	265 (96.0)	50 (18.9)	0.031
No	11 (4.0)	5 (45.4)	
Soda			
Yes	93 (33.7)	21 (22.6)	0.432
No	183 (66.3)	34 (18.6)	
Candies			
Yes	35 (12.7)	6 (17.1)	0.659
No	241 (87.3)	49 (20.3)	
Charcuterie			
Yes	28 (10.1)	2 (7.4)	0.074
No	248 (89.9)	53(21.4)	

* Pearson chi-square test.

remained for age and nutritional status (Tables 3 and 4). Children aged two years had a prevalence of high BP 2.3 times greater than that of children aged four years (PR = 2.3, 95% CI: 1.2 – 4.8; p = 0.017) and those classified as overweight had a twice greater prevalence of high BP as compared with eutrophic ones (PR = 2.0, 95% CI: 1.2 – 3.6; p = 0.014).

Discussion

Epidemiological studies have shown the importance of BP monitoring during childhood¹³⁻¹⁷. Elevated BP levels during childhood predisposes to the development of high BP in adulthood⁴.

The 19.9% prevalence of high BP in the present study was lower than that reported in some international studies with preschoolers (24.1% in the Seychelles Islands, in Africa, and 22.2% in Chinese children) and higher than that reported for Australian preschoolers (13.7%) and Canadian children (7.4%)^{16,19,17,29}. Such variations in high BP prevalence can be due to methodological differences in BP measurement, such as the type of device used and the number of measurements taken.

In Brazil, no specific study on high BP prevalence in preschoolers was found. The study by Naguettini et al¹⁵ has reported in the city of Goiânia a 1.7% prevalence of high

BP in individuals aged three to ten years, much lower than that of the present study; however, there was a two-month interval between the first and second BP measurements of those children. The first BP measurement in children tends to be higher than the second. Greater variability between the two BP measurements occurs if they are taken under distinct circumstances as compared to measurements taken on the same occasion³⁰.

On multivariate analysis, age associated directly with high BP, the greatest prevalence being observed among two-year-old children. Duncan et al³¹ have assessed the effect of the emotional status on SBP of preschoolers and reported greater anxiety on the occasion of measuring BP of two- and three-year-old children, reflecting higher SBP levels. That observation should be considered in studies of BP during childhood, and, if the child is anxious on the occasion of BP measurement, it should be repeated at another visit³¹.

Low birth weight was identified in 7.2% of the children studied, a value lower than the 9.6% found for the city of Goiânia in 2007³². No association was found between high BP and low birth weight. Tilling et al³³ have not reported a significant association between birth weight and BP in Belarusian children and demonstrated that rapid weight gain in childhood seems to be more related to high BP levels in preschoolers.

Table 3 - Raw prevalence ratio (PR) and respective confidence intervals (95%CI) of the association of high blood pressure with sociodemographic, health and anthropometric characteristics, and lifestyle in the city of Goiânia, state of Goiás, Brazil, 2012. (n = 276)

Variables	Raw PR (95%CI)	p
Sex		
Male	0.9 (0.6 - 1.5)	0.787
Female	1	-
Age group (years)		
2	2.80 (1.42 - 5.54)	0.003
3	1.97 (0.98 - 3.04)	0.056
4	1	-
Educational level (schooling years)		
< 9	1	-
≥ 9	1.3 (0.7 - 2.3)	0.370
Economic class		
A/B	1	-
C	1.1 (0.6 - 1.8)	0.805
D/E	0.9 (0.4 - 2.2)	0.883
Birth weight		
< 2,500 g	1	-
≥ 2,500 g	1.4 (0.5 - 3.9)	0.580
Family history of SAH (parents and grandparents)		
Yes	1	-
No	1.0 (0.6 - 1.7)	0.928
Exclusive MB for ≥ 4 months ³ (months)	0.8 (0.5 - 1.3)	0.415
Food ingestion more than 5x/week		
Vegetables	0.8 (0.4 - 1.4)	0.404
Fruits	1.2 (0.6 - 2.5)	0.574
Milk and derivatives	0.4 (0.2 - 0.8)	0.013
Soda	1.2 (0.7 - 2.0)	0.430
Candies	0.8 (0.4 - 1.8)	0.665
Charcuterie	0.3 (0.1 - 1.3)	0.114
TV time		
< 2h	1	-
≥ 2h	0.9 (0.5 - 1.4)	0.568
Passive smoking	1.6 (0.9 - 3.1)	0.128
Nutritional status		
Slimness/ Eutrophy	1	-
At risk for overweight	1.3 (0.7 - 2.4)	0.353
Overweight	2.1 (1.2 - 3.7)	0.010

SAH: systemic arterial hypertension; MB: Maternal breastfeeding.

Parents and grandparents with SAH were identified in a large part of the sample studied. Some studies have reported an association between the presence of that illness within the family and higher BP levels in

children^{15,17}, but the present study found no significant association between illness in the family and high BP. Further studies are required to evidence that association for preschoolers.

Table 4 - Adjusted prevalence ratio (PR) and respective confidence intervals (95%CI) of the association of high blood pressure with sociodemographic, health and anthropometric characteristics, and lifestyle in the city of Goiânia, state of Goiás, Brazil, 2012. (n = 276)

Variables	Adjusted PR (95%CI)	p
Age group (years)		
2	2.3 (1.2 - 4.8)	0.017
3	1.7 (0.8 - 3.4)	0.129
4	1	-
Nutritional status		
Slimness/ Eutrophy	1	-
At risk for overweight	1.2 (0.7 - 2.2)	0.533
Overweight	2.0 (1.2 - 3.6)	0.014

Passive smoking showed no association with high BP levels in the children studied. Studies have evidenced that smoking during pregnancy and MB seem to be more associated with high BP than passive smoking^{34,35}.

Similarly, exclusive maternal breastfeeding for at least four months was not associated with an elevation in BP. Parikh et al.³⁶, assessing the effect of maternal breastfeeding on the risk factors for CVD, have not found any relationship with BP. The protective effect of maternal breastfeeding against BP elevation in children has been reported by some studies^{11,15}. Thus, further prospective research is required to clarify that finding. Regardless of the result, that practice should be encouraged for the healthy growth and development of children¹⁵.

Food intake was not associated with BP elevation. It is worth emphasizing, however, that more than 80% of the children ingested fruits and vegetables more than five times a week. Encouraging the daily consumption of such food might prevent the appearance of CVDs¹⁰. That type of food seems to reduce the vascular inflammatory process, regulating BP levels¹⁰.

The mean time spent in front of a TV was above the cutoff point for sedentary lifestyle according to the American Academy of Pediatrics²⁴. A study has found no significant association between TV time and high BP; however, it is worth noting the positive association between TV time and overweight (data not presented)¹⁰. Thus, preventing obesity would be an indirect way to prevent high BP, because excessive weight, as already demonstrated in this and other studies, is associated with SAH development in children^{1,8,37}.

The prevalence of overweight was 11.2%, lower than that reported by Naguettini et al¹⁵ for the same city (21.0%). However, that study comprised a wider age group (from three to ten years) and a different cutoff point for excessive weight. Comparing with the 2009 Brazilian Survey on Demography and Health of Children and Women³⁸, our results show greater prevalence, since that survey found 7.5% of overweight in the Brazilian West-Central region, considering the same cutoff point used in the present study.

On multivariate analysis, overweight associated directly and significantly with high BP. The prevalence of high BP in overweight children was twice that in eutrophic children.

That finding reinforces the information obtained in several national and international studies about the deleterious relationship between overweight and hypertension during childhood¹³⁻¹⁷.

Blood pressure elevation with weight gain in children seems to result from the increase in heart rate and cardiac output. That increase activates the sympathetic nervous system, in addition to the influence of insulin resistance³⁹. The Bougalusa Heart Study has evidenced the association of overweight and high BP, which can lead to target-organ lesions, predisposing to CVD development in adulthood. Thus, actions preventing weight gain are important to avoid SAH appearance in children^{4-7,37}.

The limitations of the present study include the difficulty to calm children down before measuring BP, and the fact that BP measurement taken on one single occasion might have overestimated BP levels. The 4th Task Force recommends that, for the diagnosis of SAH in children, three BP measurements on different occasions are necessary²⁸. It is worth noting, however, that epidemiological studies on the prevalence of high BP have considered the second BP measurement or the mean BP value. Another aspect relates to the cross-sectional design of this study, which limits the interpretation of results, mainly due to the impossibility of establishing causality relationships.

Conclusions

Elevated prevalence of high BP was observed for all age groups and both sexes. Overweight and age greater than two years associated with high BP levels. The results found are compatible with those of the literature, and it is worth noting that overweight prevention plays an important role in preventing high BP³⁸.

This study provides data for new investigations, preferably prospective, to better understand the dynamics of risk factors in children. Thus, this study serves as a guide for the treatment of high BP since childhood, emphasizing the importance of health education and promotion of healthy environments.

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Author contributions

Conception and design of the research: Peixoto MRG, Jardim PCBV. Acquisition of data: Cristim PAA. Statistical analysis: Cristim PAA, Peixoto MRG. Analysis and interpretation of the data, Critical revision of the manuscript for intellectual content, Writing of the manuscript: Cristim PAA, Peixoto MRG, Jardim PCBV.

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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