

# Systemic arterial hypertension, blood pressure levels and associated factors in schoolchildren

PRISCILA HELENO<sup>1</sup>, LUCIANA EMERICK<sup>1</sup>, NICOLE MOURÃO<sup>1</sup>, DIEGO PEREIRA<sup>1</sup>, ISABELA SANTOS<sup>1</sup>, ANA SOPHIA DE OLIVEIRA<sup>1</sup>,

LUANA SANTOS<sup>2</sup>, WENDELL BILA<sup>3\*</sup>, MÁRCIA CHRISTINA ROMANO<sup>4</sup>, JOEL LAMOUNIER<sup>5</sup>

<sup>1</sup>MD. Medical diploma from Universidade Federal de São João del-Rei, Campus Centro-Oeste (UFSJ-CCO), Divinópolis, MG, Brazil

<sup>2</sup>Nurse. Nursing diploma from UFSJ-CCO, Divinópolis, MG, Brazil

<sup>3</sup>Physical Educator. PhD Student, Health Science Program, UFSJ-CCO, Divinópolis, MG, Brazil

<sup>4</sup>Nurse. PhD in Nursing. Adjunct Professor in the Nursing Program, UFSJ-CCO, Divinópolis, MG, Brazil

<sup>5</sup>MD. PhD in Public Health and Nutrition. Full Professor of the Pediatrics Department, UFSJ, São João del-Rei, MG, Brazil

## SUMMARY

**Introduction:** Hypertension is a major public health problem in contemporary times and it has high prevalence throughout the world.

**Objective:** To investigate the situation of Systemic Arterial Hypertension in schoolchildren aged 6 to 10 years in Divinópolis/MG-Brazil and associated factors.

**Method:** This is a cross-sectional, epidemiological, descriptive and analytical study, whose population was children aged 6 to 10 years enrolled in public schools in Divinópolis-MG-Brazil. Data collection was conducted from October 2014 to May 2015. Multivariate linear regressions were used to test associations between blood pressure, socioeconomic, anthropometric, dietary and physical activity.

**Results:** The prevalence of hypertension was 15.2% in a sample of 284 children and mean values of systolic blood pressure of 101.7 ( $\pm 13.2$ ) mmHg and diastolic blood pressure of 66.0 ( $\pm 11.2$ ) mmHg. The body fat percentage showed significant differences between the genders, with 24.2 and 26.2%, respectively for boys and girls. Significant associations were made between blood pressure levels, body weight, body mass index, waist circumference, body fat percentage, consumption of yogurt, beef /chicken, beans, pizza, sandwich and some behaviors variables.

**Conclusion:** The presented data show important aspects of school profile in the age range 6-10 years, especially related to the behavior of blood pressure.

**Keywords:** hypertension, child, prevalence, obesity, epidemiology.

Study conducted at Universidade Federal de São João del-Rei, Campus Centro-Oeste (UFSJ-CCO), Divinópolis, MG, Brazil

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\*Correspondence:

Address: Av. Sebastião Gonçalves Coelho, 400  
São João del-Rei, MG – Brazil  
Postal code: 35501-296  
wendellbila1@gmail.com

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## INTRODUCTION

In the group comprising chronic non-communicable diseases (cNCDs), cardiovascular diseases are the leading cause of death in Brazil and those imposing the heaviest cost burden in terms of hospital admissions in the country's health system.<sup>1</sup> This group also includes hypertension (high blood pressure, HBP), highly prevalent in the Brazilian population. Despite being asymptomatic, HBP is one of the most important risk factors for the development of cardiovascular diseases (CVD).<sup>2</sup> HBP, besides being a treatable disease, is also an important landmark, and one that can be clinically assessed, in the causal pathway leading to symptomatic cardiovascular disease.<sup>1</sup>

According to the 7<sup>th</sup> Brazilian Guideline on Hypertension, published in 2016 by the Brazilian Society of Cardiology, hypertension is defined as a multifactorial clinical condition characterized by high and sustained blood pressure levels.<sup>3</sup> It is estimated that 7.1 million people die annually worldwide due to HBP and that 4.5% of diseases are attributed to it.<sup>4</sup>

Thus, in Brazil, HBP is an important public health issue.<sup>4</sup> However, there is not a single cause for this disease, but several risk factors instead that increase the likelihood of its occurrence.<sup>5</sup> Its prevalence is high and increases at older age.<sup>6</sup>

Epidemiological studies on high blood pressure in children have been a source of consistent evidence that a high

percentage of essential arterial hypertension cases in adults initiate in childhood.<sup>7</sup> Its early recognition in childhood and adolescence is therefore critical for the prevention of various cardiovascular, renal and neurological complications.<sup>5,6</sup>

The prevalence of HBP, according to the Brazilian Society of Hypertension, varies from 22.3 to 43.9% in the adult population and, in children and adolescents, from 12 to 17%.<sup>8</sup> This variation in the findings can possibly be explained due to the diversity in the number of methodologies used (and in the number of measurements as well), age groups chosen, number of visits performed and total follow-up time.<sup>7</sup>

Thus, due to the importance of HBP for public health and the need to improve knowledge about it, especially when it affects children, this study investigates the status of HBP among schoolchildren aged 6 to 10 years and factors associated with blood pressure levels in the municipality of Divinópolis, in the midwest of the state of Minas Gerais, Brazil.

## METHOD

This is an epidemiological, observational, cross-sectional and population-based study, in which prevalence of HBP and associated risk factors were analyzed in children aged 6 to 10 years enrolled in municipal public schools in Divinópolis, Minas Gerais, Brazil, and randomly selected in order to obtain a sample of this population.

For initially calculating a simple, random sample, the number of eligible schools was considered, as were their respective distributions of students across classrooms and school grades/years when drawing the students by lot. The prevalence of high blood pressure, as estimated according to the 6<sup>th</sup> Guideline on Hypertension, was 2 to 13%,<sup>3</sup> with a confidence limit of 4%, design effect 1. The public domain statistics software package OpenEpi was used in the calculations (available from [http://www.openepi.com/Menu/OE\\_Menu.htm](http://www.openepi.com/Menu/OE_Menu.htm)).

A universe of 6,030 students aged 6-10 years was used, and those duly enrolled in the 35 municipal public system schools were included as the eligible population, according to data provided by the Municipal Department of Education of Divinópolis, Minas Gerais, Brazil. Schools that did not have any students enrolled in at least two grades/years or those with fewer than 15 students enrolled in at least two grades/years could not participate in the study. Of the 27 schools remaining, 16 were drawn by lot. As per the calculated sample size, 260 participants would be required in order for the study to be appropriately conducted. A total of 284 students who consented to participate were included in the study, of whom 132 were

boys and 152 were girls, and from whom data to be used in the study was collected.

This age group (between 6 and 10 years) corresponds to an important time window that is well suited for capturing the way children begin to develop their personal habits – it is a moment in time at which children shape their aesthetic preferences and patterns as mediated by the media and by their social experiences with other children; since they spend much of their time at school, this expands their repertoire of habits, which they had previously learned from their families only.<sup>9</sup>

The students' parents/guardians were informed about the study by means of a school memo. Participation only occurred after both parents/guardians and child (at the time of data collection) had signed the respective free and informed consent forms (FICF). Children not belonging to the age group 6-10 years or previously diagnosed with secondary HBP, cardiovascular disease or renal insufficiency, or those who had not signed the FICF (or whose parents/guardians had not signed it), were excluded from the study.

Data collection in schools was preceded by a previous step aimed at clarifying to school directors and teachers the study objectives and procedures to be carried out. The study was conducted in compliance with the guidelines contained in Resolution 466/12 of the National Health Council of the Brazilian Ministry of Health and approved by the Research Ethics Committee at Universidade Federal de São João del Rei-UFSJ (CAAE 25332213.7.0000.5545).

Data collection was performed in the period from October 2014 to May 2015 by a previously trained team. The children responded to the questionnaires, underwent an anthropometric assessment, and had their blood pressure measured, all of which followed standardized procedures.<sup>10-12</sup> All anthropometric parameters (weight, height, waist circumference), in addition to triceps and calf skin folds, were measured in triplicates, and the results were expressed as the means obtained, all of which were coded and stored with the aid of an SPSS statistical software, version 20.0 for Windows, which was used in the statistical analyses. Body mass index (BMI) and its respective z-scores were calculated, as was the percentage of body fat (%BF), according to the equation proposed by Slaughter et al. in 1988.<sup>13</sup>

Questionnaires with information relative to high blood pressure and its risk factors were administered to and answered by the children's parents and/or guardians. The instruments used are the following:

- Socioeconomic questionnaire: by the Brazilian Association of Population Studies (ABEP) of 2014,<sup>14</sup> and classifications according to scores ranging from 0 to

100 points, yielding stratifications into classes A, B1, B2, C1, C2, D and E.

- Eating habits: questionnaire on dietary frequency, developed by del Pino,<sup>15</sup> in 2009. The evaluation was made considering the foods chosen for each daily meal.
- Quality of life: information on the children's perception of their satisfaction with daily activities, gathered with the AUQUEL questionnaire, presented by Manificat and Dazord<sup>16</sup> in 2002, in which the satisfaction phases were presented by using four aspects expressing a child's different preferential conditions.
- Physical activity: the Netherlands Physical Activity Questionnaire (NPAQ) questionnaire.<sup>17</sup> The level of physical activity was assessed as a continuous variable.

Systemic blood pressure was measured by using an oscillometric method with an OMRON HEM-705CP automatic device, validated for research purposes, verified and approved by Inmetro and the Brazilian Society of Cardiology, coupled to a child's armband, with a circumference of 10-22 cm, in one single visit. The first measurement was performed five minutes after the child had assumed a sitting position, and two minutes subsequent to that, between the two other measurements. The arithmetic mean of the measured values was used.

The descriptive results were obtained by means of the measures of central tendency (mean and median) and dispersion (standard deviation and interquartile range).

The prevalence of high blood pressure was estimated in each age group by gender, age and height percentiles, according to the guidelines set in 2009 by the World Health Organization (WHO) and the 7<sup>th</sup> Brazilian Guide-

line on Hypertension.<sup>3,18</sup> HBP values were then compared with the associated variables by using multivariate linear and logistic analyses. Comparisons of systolic and diastolic blood pressures, as well as BMI, %BF, and waist circumference (WC) were drawn between the genders by using Student's t-test or Mann-Whitney test, according to the normality of the data. A level of significance  $\alpha=5\%$  was used.

## RESULTS

The mean age of the sample was 8.2 ( $\pm 1.4$ ) years, with 53.5% of participants being females and a total of 67.5% belonging to classes C, D and E. The description of the remaining variables in the study can be seen in Table 1. The SBP in boys was 101.9 ( $\pm 14.2$ ) mmHg and 101.6 ( $\pm 12.3$ ) mmHg in girls. The mean DBP was 65.4 ( $\pm 12.1$ ) mmHg and 66.5 ( $\pm 10.5$ ) mmHg for boys and girls, respectively.

The prevalence of high blood pressure was found to be 15.2% (classified as stages 1 and 2), as described in Table 2.

%BF means differed significantly between genders: 24.2 and 26.2% body fat, respectively, for boys and girls.

The multivariate linear regression analysis, adjusted for gender and age, showed significant associations ( $p<0.05$ ) between high blood pressure (SBPmean = 101.7 mmHg, DBPmean = 66.0 mmHg), weight z-score, BMI z-score, cardiovascular risk according to WC,<sup>19,20</sup> excess weight according to the %BF,<sup>21,22</sup> consumption of beef/chicken, beans, yogurt and some behavioral variables, as described in Table 3.

The logistic regression analysis, also adjusted for gender and age, showed significant associations ( $p<0.05$ ) between elevated HBP levels (hypertension stages 1 or 2), and weight z-score, BMI z-score, cardiovascular risk ac-

**TABLE 1** Anthropometric, socioeconomic and physical activity variables evaluated in schoolchildren aged 6 to 10 years in the city of Divinópolis, MG, 2015. n=284.

	n Sample	Mean	Standard deviation	Median	IQR
SBP (mmHg)	283	101.7	13.2	100.0	92.3-111.0
DBP (mmHg)	283	66.0	11.2	64.0	58.3-71.7
Weight (kg)	284	31.2	9.5	29.3	24.4-35.4
Height (cm)	284	132.9	10.4	133.0	125.5-141.0
BMI (kg/cm <sup>2</sup> )	284	17.4	3.3	16.5	15.1-18.8
WC (cm)	284	59.5	8.3	56.7	54-63.4
%BF	284	25.2	8.6	23.8	19.1-30.7
Level of physical activity*	195	1.6	0.7	1.6	1.3-2.1
Number of hours spent in front of a TV, computer, etc.	243	3.0	1.7	3.0	2.0-4.0
Socioeconomic level**	277	19.2	6.6	19.0	16-24

SBP: systolic blood pressure; DBP: diastolic blood pressure; WC: waist circumference; BMI: body mass index; %BF: percentage of body fat; IQR: interquartile range.

\*According to the NPAQ questionnaire,<sup>17</sup> on a scale of 1-5 points.

\*\*According to the ABEP questionnaire.<sup>14</sup>

**TABLE 2** Prevalence of high blood pressure among the school children in the study, Divinópolis, MG, Brazil, 2015. n=283.

BP classification	N	%	Percentages*
Normal	213	75.3	< 90
Pre-hypertension	27	9.5	≥ 90 and < 95
HBP stage 1	35	12.4	≥ 95 and < 99 + 5 mmHg
HBP stage 2	08	2.8	> Stage 1
Total	283	100	

BP: blood pressure; N: number of subjects.

\*According to the 7<sup>th</sup> Guideline on Hypertension.<sup>3</sup>**TABLE 3** Final multivariate and logistic linear regression model of blood pressure levels among schoolchildren aged 6 to 10 years, Divinópolis, MG, and significantly associated variables†. n=284.

Variable	β	CI	p-value
<b>Linear regression</b>			
SBP			
z-score weight	0.417	2.6 to 4.9	<0.05
z-score BMI	0.410	2.7 to 4.6	<0.05
CVR-WC (Bergman 2010, Sant 2009)	0.373	7.9 to 14.5	<0.05
Consumption of yogurt*	0.162	0.7 to 5.1	0.007
Sports practice°	0.141	0.5 to 6.1	0.023
Sleeping away from home°	0.136	0.5 to 4.5	0.024
DBP			
z-score weight	0.354	1.7 to 3.7	<0.05
z-score BMI	0.333	1.7 to 3.4	<0.05
Excess weight, based on %BF	0.123	0.1 to 5.5	<0.05
CVR-WC	0.330	5.6 to 11.3	<0.05
Consumption of beans*	-0.118	-3.6 to 0.0	0.049
Consumption of beef/chicken*	-0.124	-3.9 to -0.3	0.038
<b>Logistic regression**</b>			
z-score weight	0.663	0.5 to 0.9	0.020
z-score BMI	0.607	0.5 to 0.8	<0.05
CVR-WC	0.243	0.1 to 0.5	<0.05
Hours in front of a screen	0.816	0.7 to 0.9	0.044
Consumption of yogurt*	0.584	0.4 to 0.9	0.011
Consumption of pizza and sandwiches*	0.536	0.3 to 0.9	0.033

SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; %BF: percentage of body fat; CVR-WC: cardiovascular risk based on waist circumference; β: level of association; CI: confidence interval.

‡ Significant, at a significance level of 0.05.

\*According to the presence of the food item in each daily meal.

°Levels of satisfaction pointed out based on the visualization of smiley faces (from the saddest to the most cheerful).

\*\*Associations between the presence of abnormal blood pressure levels (stages 1 or 2) and other variables.

cording to WC, amount of screen hours, consumption of yogurt, pizza and sandwiches (Table 3).

## DISCUSSION

The 15.2% prevalence of high blood pressure found in our study was higher than the 9.6% demonstrated by Bloch et al.<sup>23</sup> in their ERICA study (Study of Cardiovascular Risk Factors in Adolescents) with Brazilian adolescent students

in 2016, and also higher than the 13.8% found by Costanzi et al.<sup>24</sup> in 2009, who evaluated children aged 7-12 years from Caxias do Sul, in the state of Rio Grande do Sul, as well as other studies.<sup>25,26</sup> Nevertheless, the HBP range found in our study was within the variation between 2 and 13% described by Gomes and Alves<sup>27</sup> in 2009, in their study with high school students in the State of Pernambuco, Brazil. However, HBP prevalence proved to be slightly



below 16.6% when using the first measurement, as demonstrated by Rezende et al. in 2003 among schoolchildren aged 7-14 years in Barbacena, in the state of Minas Gerais.<sup>28</sup>

The prevalence of pre-hypertensive individuals found in our study was also lower than the 14.5% reported by Bloch et al.<sup>23</sup>

The Brazilian Society of Cardiology highlights instances in which the prevalence of pre-hypertension was 12-17%, in single measurements, especially in overweight and obese adolescents,<sup>8</sup> a value that was higher than that found in the present study for borderline BP, which was 9.5%.

There were no statistically significant differences in BP values between boys and girls, similarly to the findings published by Ferreira and Aydós,<sup>25</sup> in 2010, who did not find significant differences in pressure levels between genders either.

Obesity is probably the leading associated condition for primary arterial hypertension in children and adolescents, accounting for more than half the risk of developing HBP. Diet, physical exercise and weight loss are cited as important factors for lifestyle changes.<sup>8</sup> In this context, %BF showed significant differences between genders, thus confirming the already well-established knowledge of the largest fat component in girls.

Brazilian studies published by Queiroz et al.,<sup>26</sup> in 2008, Nogueira et al.,<sup>29</sup> in 2007, and Crispin et al.,<sup>30</sup> in 2014, showed a positive association between BMI and increased blood pressure. An American study also attributed altered BP levels to a high prevalence of overweight among children and adolescents.<sup>31</sup> This possibly corroborates the positive associations in the present study between blood pressure levels and weight z-score, BMI z-score, overweight according to %BF and cardiovascular risk according to WC, indicators known to be associated with cardiovascular diseases.

The positive associations found between blood pressure levels and waist circumference are corroborated by the findings of Costanzi et al.,<sup>24</sup> 2009, showing that children with an increased WC were 2.8 times more likely to have HBP. Despite the fact that this same study showed that individuals with high scores in the National Economic Index are 2.6 times more likely to have HBP, we failed to find significant associations between these variables, a result that was not obtained in the study by Rosaneli et al.,<sup>32</sup> in 2013, either.

There were other significant and positive associations between variables and BP levels, such as consumption of yogurt, pizzas and sandwiches, but there were also other negative associations, such as consumption of beans and beef/chicken. In Brazil, the Ministry of Health<sup>33</sup> states

that animal foods are good sources of protein and most of the vitamins and minerals we need; still, they have characteristics that may favor the risk of obesity, heart disease, and other chronic diseases. Animal foods can also contain cholesterol, which can build up in blood vessels, thereby contributing to an increased risk of heart diseases. The document goes on to recommend three servings of milk and dairy products per day.

Even though breastfeeding time was not assessed in the present study, children who are breastfed for less than six months are known to be more prone to have HBP as compared to those who were breastfed for a longer period, which thus suggests a protective effect of breastfeeding against HBP in this population.<sup>34</sup> Furthermore, birth weight is known to be associated with the appearance of cNCDs, such as obesity and diabetes, according to the conclusions in the studies conducted by Jornayvaz et al.,<sup>35</sup> and Yu et al.<sup>36</sup>

Because this is a study with an observational and cross-sectional design, its cause-and-effect analysis is limited. Additionally, one must bear in mind the recommendation of taking blood pressure measurements in more than one visit in order to confirm the diagnosis of high blood pressure.

The students' individual results – namely blood pressure levels, nutritional profile (BMI) and appropriate recommendations for further referral in order to confirm possible diagnoses of high blood pressure – were addressed, sealed and sent to school directors, in writing, so that the information could be conveyed to the children's parents/guardians.

## CONCLUSION

The data displayed in our study reveal important aspects regarding the profile of schoolchildren aged 6-10 years, especially in terms of blood pressure behavior. It is an important stage in the development of children as far as the formation of life habits is concerned. The results offer valuable academic information on monitoring during this period of time, which is crucial for the children's growth and development and can be used to educate the population about health issues.

## RESUMO

Hipertensão arterial, níveis pressóricos e fatores associados em escolares

**Introdução:** A hipertensão arterial sistêmica representa um importante problema de saúde pública na contemporaneidade, pois tem alta prevalência em todo o mundo.

**Objetivo:** Investigar a situação da hipertensão arterial sistêmica em escolares de 6 a 10 anos no município de Divinópolis, MG, Brasil e fatores associados.

**Método:** Este estudo tem caráter epidemiológico de corte transversal, descritivo e analítico, cuja população foi de crianças de 6 a 10 anos matriculadas em escolas públicas municipais de Divinópolis, MG, Brasil. A coleta dos dados foi realizada no período de outubro de 2014 a maio de 2015. Regressões lineares e logísticas multivariadas foram utilizadas para testar associações entre pressão arterial, variáveis socioeconômicas, antropométricas, alimentares e atividade física.

**Resultados:** A prevalência de hipertensão arterial foi de 15,2% em uma amostra de 284 crianças, cujos dados forneceram valores médio de pressão arterial sistólica de 101,7 ( $\pm 13,2$ ) mmHg e de pressão arterial diastólica de 66,0 ( $\pm 11,2$ ) mmHg. O percentual de gordura corporal apresentou diferenças significativas entre os sexos, sendo 24,2% e 26,2% de gordura corporal, respectivamente, para meninos e meninas. Foram encontradas associações significativas entre níveis pressóricos, peso corporal, índice de massa corporal, circunferência de cintura, percentual de gordura corporal, consumo de iogurte, carne bovina/frango, feijão, iogurte, pizzas, sanduíches e algumas variáveis comportamentais.

**Conclusão:** Os dados apresentados revelam aspectos importantes relativos ao perfil de escolares na faixa etária de 6 a 10 anos, especialmente relacionados ao comportamento da pressão arterial.

**Palavras-chave:** hipertensão, criança, prevalência, obesidade, epidemiologia.

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