ESTUDO DA PREVALÊNCIA DA HIPERTENSÃO ARTERIAL EM CRIANÇAS E ADOLESCENTES NA REGIÃO DE LISBOA E VALE DO TEJO

STUDY OF THE PREVALENCE OF HYPERTENSION IN CHILDREN AND ADOLESCENTS IN LISBON AND TEJO VALLEY REGION

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Resumo

Introdução: *A hipertensão arterial (HTA) é um fator de risco importante de doença cardiovascular (DCV) em qualquer idade. Estima-se uma prevalência na criança de 3-5%. O conhecimento da sua prevalência permite adequar medidas de controlo, tratamento e prevenção, procurando diminuir a morbilidade e mortalidade associadas à DCV.*

Objetivos: *Avaliar a prevalência da HTA em crianças e adolescentes em idade escolar e o efeito de variáveis sociodemográficas e somatométricas no perfil tensional.*

Metodologia: *Estudo multicêntrico, observacional, prospetivo e transversal que decorreu entre 2016 e 2019. Amostra com crianças entre os 6 e 18 anos, residentes na região de Lisboa e Vale do Tejo. Realizada medição da pressão arterial (PA) pelo método oscilométrico, em ambiente escolar. A classificação do perfil tensional em PA normal, PA elevada (PAE) e hipertensão arterial (HTA), baseou-se nos critérios da ESH-2016. Registados género, idade, raça, escolaridade, peso e estatura. Realizada análise estatística descritiva.*

Resultados: *Participantes: 1245 crianças, 215 participantes entre os 6-10 anos (17%); 720 entre 11-15 anos (58%) e 310 com 16 -18 anos (25%). Caucasianos: 88%; género feminino: 635 (51%). Registaram-se 16% com excesso de peso e 7% de obesos.*

A prevalência de HTA é de 8,4% e de PAE 12,8%. Registaram-se entre os 6-10 anos 5,6% de casos de HTA; 11-15 anos: 8,6% e 16-18 anos: 10%. Nos rapazes 10,5% tinham HTA (vs F.6,5%-p<0,001). Na raça caucasiana 8,7% apresentavam HTA, 6% na raça negra e 5,9 % entre asiáticos. As crianças com excesso de peso ou obesidade apresentaram valores mais elevados de HTA, 17% e 26% respetivamente.

Discussão/Conclusão: *A prevalência de HTA é elevada (8,4%) e aumenta com a idade, género masculino e nível de escolaridade mais avançado. Excesso de peso e obesidade contribuem para o aumento dos casos de HTA.*

Palavras-Chave:
Hipertensão Arterial, Pressão Arterial Elevada, Criança e Adolescente

Abstract

Introduction: *Hypertension (HTN) is an important risk factor for cardiovascular disease (CVD) at any age. Its prevalence in children is estimated at 3-5%. The knowledge of its prevalence allows for the adequacy of control, treatment and prevention measures, to decrease the morbidity and mortality associated with CVD.*

Objectives: *To assess the prevalence of hypertension in school-age children and adolescents and the effect of sociodemographic and clinical variables on the blood pressure profile.*

To compare the values using the classification criteria of the blood pressure defined by the European Society of Hypertension (ESH-2016) with the American Academy of Pediatrics criteria (AAP-2017).

Methodology: *Multicenter, observational, prospective, cross-sectional study conducted between 2016 and 2019. The convenience sample is composed of children aged between 6-18 years, living in Lisbon and Tejo Valley Region.*

Blood pressure (BP) measurement by oscillometric method was performed in school environment. The classification of the BP profile into

Keywords: Hypertension, Elevated Blood Pressure, Children and Adolescent

normal BP (NBP), elevated BP (EBP) and hypertension (HTN) was based in ESH-2016 criteria. Age, gender, race, education level, weight and height were recorded. A descriptive statistical analysis was performed.

Results: *Participants: 1245 children, 215 from 6-10 years (17%); 720 from 11-15 years (58%) and 310 from 16-18 years (25%). Caucasian:88%; Female gender: 635 (51%). There were 16% overweight and 7% obese.*

The prevalence of HTN is 8.4% and EBP is 12.8%. Between 6-10 years old: 5.6% had HTN; 11-15 years old: 8.6% and 16-18 years old: 10%. In boys, 10.5% had HTN (vs F.6.5%-p<0.001). Caucasians: 8.7% with HTN, 6% in blacks and 5.9% among Asians. Children who were overweight or obese showed higher values of hypertension, 17% and 26% respectively.

Discussion/Conclusion: *The prevalence of hypertension is high (8.4%) and it increases with age, male gender and more advanced level of education. Overweight and obesity contribute to the increase of HTN cases.*

Introduction

Hypertension is a public health problem worldwide, affects people of all age groups and it is an important, independent and potentially reversible risk factor for cardiovascular disease (CVD) and chronic kidney disease[1,2,3]. According to the World Health Organization (WHO), CVD is a major cause of adult morbidity and mortality, accounting for about 17.9 million deaths per year worldwide (32% of deaths worldwide in 2019)[4]. In Portugal approximately 3 million Portuguese adults have hypertension.[5]

In recent decades, the increasing interest on this problem in children is the result of the realization that its prevalence is significant and growing, as demonstrated by several papers that have emerged after the publication in 2004 of the Fourth Report on the Diagnosis, Evaluation and Treatment of High Blood Pressure in Children and Adolescents [6,7]. In Europe the estimated prevalence is 3-5%[8] and in the United States 3-4%, [9,10] with a tendency to increase in association with different risk factors, such as obesity [11,12]. The criteria to classify the blood pressure (BP) profile and define hypertension have been changing over the last years and recently the European Society of Hypertension (ESH-2016) and American Academy of Pediatrics (AAP-2017) have published new criteria [8,9].

In the pediatric age the disease is silent in most cases and therefore target organ damage is present in many children at the time of diagnosis [8,9,13,14].Early diagnosis allows for timely and appropriate intervention, which may delay or prevent disease progression [11,14,15].

In Portugal there is a paucity of studies on the prevalence of changes in BP profile in pediatric age [16] and the published works referring to young ages, from 6 years old and above, are already a result of the present study [17].

This study is part of the study of prevalence of hypertension in pediatric age (EPHTAped) conducted by the SPP's Working Group on hypertension, as part of a global strategy aimed at assessing the extent of this problem in the younger population in Portugal (mainland and islands). The main objective of this study is to assess the BP profile of school-age children living in the region of Lisbon and Tejo Valley, contributing to increasing the degree of knowledge about our reality. A second objective is to try to identify associated risk factors (modifiable and non-modifiable) so that control and prevention measures can be implemented, alerting public opinion, health technicians, and governmental bodies to changes that may be necessary. Acting early in prevention is essential.

Methods

Study Type and Date: multicenter, observational, prospective, cross-sectional study, which took place between January 2016 and June 2019.

Location: 8 public and private schools, in the region of Lisbon and Tejo Valley

Sample: The convenience sample is composed of children aged between 6 and 18 years (on December 31st of the calendar year), from the schools mentioned, who agreed to take part in the study. The sample size and age stratification were defined based on the published results of the 2011 Census [18].

The participants were distributed into 3 groups according to age: Group I: 6-10 years; Group II: 11-15 years and Group III: 16-18 years. According to the level of education, 4 groups were formed. Group A includes pre-school and primary school (1st to 4th grade), Group B includes 5th and 6th grade, Group C includes middle school (7th, 8th, and 9th grade), and Group D, high

school (10th, 11th, and 12th grade).

Exclusion Criteria: age outside the defined range, inability to collect all the clinical or socio-demographic data required (age, gender, race, level of education, weight or height), and lack of explicit informed consent.

Evaluated Parameters: The study participants answered a closed-ended survey about age, gender, race/ethnicity, level of education and use of regular medication.

Clinical somatometric parameters (Weight (Kg) and Height (cm)) were recorded were recorded at the time BP was assessed, using suitable and calibrated equipment. The Centers for Disease Control and Prevention (CDC 2000) tables [19] were used to define the height percentile. Then, Body Mass Index (BMI) was calculated and the classification into Low Weight, Normal Weight, Overweight, and Obese was based on the criteria and tables published by the WHO in 2007 [20].

BP measurement was performed in a school environment, previously prepared for this purpose, following the recommendations published by ESH-2016 and AAP-2017 [8,9]. The team of evaluators prepared for this purpose included students from the Faculty of Medicine of the University of Lisbon, nurses, pediatricians, pediatric nephrologists and pediatric cardiologists. Blood pressure was measured by the oscillometric method, using validated and calibrated devices [21]. Three measurements were made with appropriate brachial perimeter cuffs and the mean value of these measurements was considered.

The BP profile classification was based on the criteria published by ESH-2016 [8]: Normal BP (NBP), elevated BP (EBP) and hypertension (HTN) according to the values for age, sex and height. Up to 16 years of age, the classification of the BP profile was based on the percentile values (Pc) of systolic blood pressure (SBP) and/or diastolic blood pressure (DBP), considering SBP and/or DBP values below the 90th percentile as NBP, equal to or greater than the 90th percentile and below the 95th percentile as EBP and equal to or greater than the 95th percentile as hypertension. Absolute BP values were used from age 16 onwards (similarly to adult) and following the criteria defined by ESH-2016 SBP and/or DBP values lower than 130/80 mmHg were considered as NBP, EBP for SBP and/or DBP values equal to or higher than 130-139/80-89 mmHg and hypertension the SBP and/or DBP values equal to or higher than 140/90 mmHg. The prevalence values of EBP and hypertension in this population were compared by applying the ESH-2016 criteria with the values obtained by applying the revised criteria published by the AAP in the 2017 guidelines [9].

Data analysis: We analyzed the distribution of the age, gender, race, education level and BMI value, on the BP profile, either alone or in association (2 or more variables).

Statistical analysis was performed with Windows 2019 Microsoft Excel. A descriptive statistical analysis of the results was performed. Non-parametric tests and exploratory factor analysis were applied. A p value < 0.05 was considered statistically significant. Matlab, R and SPSS software were used to organize and model the data. The first step consisted in organizing the data by obtaining some simple measures by descriptive statistics techniques, means, medians, percentages and graphical analysis (qq plots, whiskers diagrams, cheese diagrams). In a preliminary analysis of the data and taking into account the non-quantitative nature of some of the variables, some measures of association were calculated, Spearman's non-parametric correlation coefficient, and several tests were performed, namely Friedman's non-parametric test, median test, order test, and sign test so that we could identify potential explanatory variables or compare different groups. The usual F-tests (ANOVA several factors) were used in order to identify variables that contributed significantly to the change in blood pressure profile. For comparison of groups, t-test for comparison of means, t-test for comparison of medians, t-test for comparison of proportions, t-test for comparison of orders were used.

Authorizations to carry out the study: The study is anonymized and was approved by the Ethics Committee of HSM-CHULN, the Directorate-General of Health, the Directorate-General of Education and the National Data Protection Commission. The study was also approved by the directors of the school groups involved and all participants gave written informed consent, obtained through the schools from their parents and/or caregivers.

Results

General characterization of the sample (Table 1)

A total of 1245 children were included. The mean age was 13 + 3.07 years (6-18 years) and the mode was 14 years.

In the 6-10 age group there were 215 children (17%), in the 11-15 age group there were 720 (58%), and in the 16-18 age group there were 310 (25%).

The gender distribution revealed a slight predominance of girls (51%), with a female to male ratio of 1:0.98. The distribution between girls and boys was very similar in all age groups.

The majority of participants were caucasian (88%), a trend that is observed in all age groups, with the remaining being black (8%) and asian (4%). The 11-15 age group has the highest percentage of black and asian children, with 7.6% and 5.4%, respectively.

The distribution according to the level of schooling revealed 24% of children were in grades 1 to 6, 56% were in middle school, and 20% in high school. We aggregated the children in primary school and 5th and 6th grades due to the small size of the latter.

The somatometric evaluation and BMI calculation revealed overweight in16% of the children, obesity in 7% and underweight in less than 1%.

In the 6-10 age group 13% were overweight and 9% were obese. In the 11-15 age group, 18% were overweight and 7% were obese, and in the 16-18 age group, 13% were overweight and 6% were obese. In males, the distribution of overweight and obese cases was 13% and 7.5% respectively, and in females, 18.5% and 7.2%. The higher percentage of overweight cases in girls compared to boys was associated with a statistically significant difference (p=0.001).

In the caucasian race 16% were overweight and 8% were obese, in the black race 17% were overweight and 6% were obese, and among asians 18% were overweight and 4% were obese. A proportionality analysis according to

Table 1 - Sociodemographic characteristics

Sociodemographic characteristics	n= 1245 (%)
Age, Years	Average ± SD 13,3 ± 3,07 (6-18)
6-10	215 (17%)
11-15	720 (58%)
16-18	310 (25%)
Gender	
Female	635 (51%)
Male	610 (49%)
Race	
Caucasian	1095 (88%)
Black	99 (8%)
Asian	51 (4%)
Body Mass Index (BMI)	Average ± SD 20,45 ± 3,8 (13,3-31,8)
Underweight	4 (1%)
Normal Weight	950 (76%)
Overweight	199 (16%)
Obesity	92 (7%)
Education level	
A (Primary School – 1-4th grade)	260 (21%)
B (Middle School – 5-6th grade)	42 (3%)
C (Middle School – 7-9th grade)	699 (56%)
D (High School – 10-12th grade)	244 (20%)

sample size reveals that the percentage of overweight and obese cases in the black and asian groups is higher than in the caucasian group ($p < 0.01$).
Regarding the level of education, the distribution of overweight and obesity cases is higher in group C with 16% and 8%, respectively.
In summary, there were more cases of high BMI (overweight/obesity) in the 11-15 year age group (25%), female gender (25.7%), 7th-9th grade (24%), and black (23%) and asian (22%).

Table 2 - Blood Pressure Profile Classification. ESH-European Society of Hypertension-2016; AAP – American Academy of Pediatrics -2017. NBP: Normal Blood Pressure; EBP: Elevated Blood Pressure; HTA: Hypertension

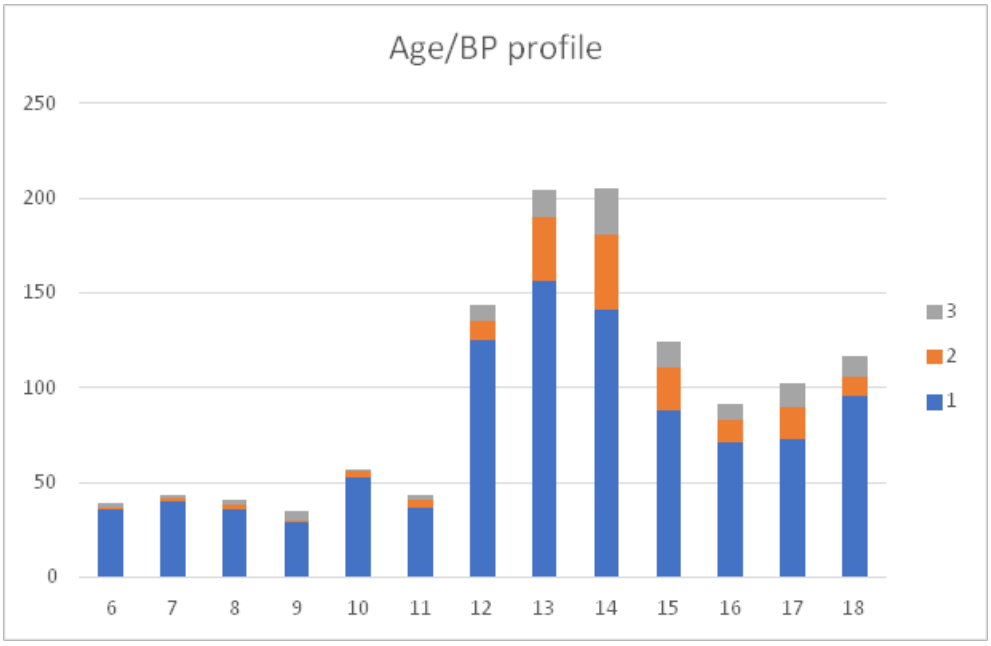
Blood Pressure Profile Classification			
BP Profile	ESH n=1245 (%)	AAP n=1245 (%)	p value
NBP	981 (78,8%)	891 (71,6%)	.0001
EBP	159 (12,8%)	182 (14,6%)	.001
HTN	105 (8,4%)	172 (13,8%)	.0001

Analysis of the distribution of BP Profile (NBP, EBP, HTN) according to age, gender, race, education level and BMI value (Table 3)

Age / BP Profile

Graph 1 reflects the distribution of BP profile according to age. In the overall sample, age group I accounts for 0.9% of HTN cases (and 0.7% of EBP), group II for 4.9% (and 8.9% of EBP), and group III for 2.48% (and 3.13% of EBP). In group I, 4.2% of the population had EBP and 5.6% had hypertension. In group II, the group with the highest number of participants in the sample, 15.4% had EBP and 8.6% had hypertension. In group III, the second largest group in the sample, 12.5% presented EBP and 10% with HTN (Graph 1).

Graph 1. Distribution of Blood Pressure (BP) profile according to age. 1-Normal BP; 2 – Elevated BP; 3- Hypertension



Gender / BP Profile

In the overall sample 5.1% of the cases of hypertension occurred in boys and 3.9% in girls.

In males compared to females, there were more cases of EBP (14.75% vs 10.86%) and hypertension (10.5% vs 6.45%), and the difference was statistically significant (p=0.001).

Race / BP Profile

In the overall sample the caucasian race contributed 7.7% of cases to the HTN profile, followed by blacks with 0.48% and asians with 0.24%.

Analysis of the BP profile in each group revealed altered BP profile in 21.4% of caucasians, 12.6% with EBP and 8.7% with hypertension, followed by blacks with EBP in 15.2% and hypertension in 6%, and asians with EBP in 11.8% and hypertension in 5.9%.

Education level (level of schooling) / BP profile

In grades 1 to 6, 5.6% of children had EBP and 5.3% had hypertension; however, in middle school and high school, higher percentages of cases with altered BP profiles were recorded, with 9.4% of children with hypertension in each group, with a statistically significant difference (p<0.001).

Body Mass Index Class / BP Profile

In the group with overweight and obesity there was a higher percentage of cases with EBP and hypertension.

In the normal weight group, 5% had hypertension. In the overweight group, 17% had hypertension. In the obese group, 26% had hypertension. It should be noted that those with altered BMI (overweight or obesity) and altered blood pressure profile (EBP or HTN) represent 8.7% of the individuals in this population.

Table 3 – Percent distribution (%) of the pediatric population (6 -18 years old) residing in the LVT region by age, gender, race, education level, BMI value and BP profile

Variable	NBP (n; %)	EBP (n; %)	HTN (n;%)	Total (n)
Age				
6-10	194	9 (4,2)	12 (5,6)	215
11-15	547	111 (15,4)	62 (8,6)	720
16-18	240	39 (12,5)	31 (10)	310
Gender				
Female	525	69 (10,85)	41 (6,45)	635
Male	456	90 (14,8)	64 (10,5)	610
Race				
Caucasian	801(78,6%)	138 (12,6)	96 (8,8)	1035
Black	78 (78,8)	15 (15,2)	6 (6)	99
Asian	42 (82,3)	6 (11,8)	3 (5,9)	51
Education level				
A (Primary School – 1-4th grade)	232	14	14	260
B (Middle School – 5-6th grade)	37	3	2	42
C (Middle School – 7-9th grade)	520	113	66	699
D (High School – 10-12th grade)	192	29	23	244
BMI				
Normal Weight	793	110 (11,6)	47 (4,9)	950
Overweight	132	33	34	199
Obesity	53	15	24	92
Underweight	3	1	0	4

Analysis of the association between 2 variables and the BP Profile distribution (NBP, EBP, HTN) (Table 4)

Age/Gender/BP Profile

In group I elevated blood pressure (EBP or hypertension) was more frequent in girls, and this tendency is reversed in groups II and III, with the asymmetry between boys and girls becoming more evident in group III (EBP 17.4% vs. 7% and hypertension 15.5% vs. 3.5%), with statistical significance ($p<0.001$).

Age/BMI class/BP profile

In all age groups, children with overweight or obesity recorded the highest number of cases of high BP (EBP and hypertension), but it is older children, especially those aged 11-15 years, with overweight or obesity, who show a significant increase in the number of cases of EBP and hypertension (16% and 32%, respectively).

Gender/BMI class/BP profile

There are more children with hypertension and children with obesity in males, but if gender and BMI class are associated, it was found that there is a higher percentage of obese girls with hypertension (28%) compared to obese boys (24%).

Race/BMI class/BP profile

Due to the great asymmetry in the sample size, these

Table 4 – Percentage distribution (%) of the pediatric population (6-18 years old) residing in the LVT region by age and gender; age and BMI; gender and BMI; race and BMI and BP profile

Age/Gender/BP	NBP (n)	EBP (n; %)	HTN (n;%)	Total (n)
6—10	**194**	**9**	**12**	**215**
M	101	4 (3,6)	6 (5,4)	111
F	93	5 (4,5)	6 (5,8)	104
11—15	**547**	**111**	**62**	**720**
M	243	57(17,1)	32 (9,6)	332
F	304	54(13,9)	30 (7,7)	388
16—18	**240**	**40**	**31**	**310**
M	112	29(17,4)	26 (15,5)	167
F	128	10(7)	5 (3,5)	143
Total	981	159	105	1245
Age/BMI/BP	**NBP (n)**	**EBP (n; %)**	**HTN (n;%)**	**Total (n)**
6—10	**194**	**9**	**12**	**215**
Normal weight	157	5 (3)	7 (4,1)	169
Overweight	20	1(4,5)	1 (4,5)	22
Obesity	17	3(12,5)	4 (16,7)	24
Underweight	0	0	0	0
11—15	**547**	**111**	**62**	**720**
Normal weight	434	77(14,4)	24 (4,5)	535
Overweight	84	25(19)	22 (16,8)	131
Obesity	26	8(16)	16 (32)	50
Underweight	3	1(25%)	0	4
16—18	**240**	**39**	**31**	**310**
Normal weight	207	28(11)	16 (6,2)	251
Overweight	24	6(15)	10 (25)	40
Obesity	9	5(26,3)	5 (26)	19
Underweight	0	0	0	0
Total	981	159	105	1245

Gender/BMI/BP	NBP (n)	EBP (n; %)	HTN (n;%)	Total (n)
Male	**456**	**90**	**64**	**610**
Normal weight	390	60 (12,5)	31 (6,4)	481
Overweight	39	20(25)	22 (27)	81
Obesity	25	10(21,7)	11 (24)	46
Underweight	2	0	0	2
Female	**525**	**69**	**41**	**635**
Normal weight	403	50 (10,7)	16 (3,4)	469
Overweight	93	13 (11)	12 (10,2)	118
Obesity	28	5 (10,86)	13 (28,3)	46
Underweight	1	1 (50)	0	2
Total	981	159	105	1245
Race/BMI/BP	**NBP (n)**	**EBP (n;%)**	**HTN (n;%)**	**Total (n)**
Caucasian	**861**	**138**	**96**	**1095**
Normal weight	700	94 (11,3)	41(4,9)	835
Overweight	112	29 (16,7)	32 (18,5)	173
Obesity	46	15 (17,85)	23 (27,4)	84
Underweight	3	0	0	3
Black	**78**	**15**	**6**	**99**
Normal weight	61	10 (13,3)	4 (5,3)	75
Overweight	12	4 (23,5)	1 (5,9)	17
Obesity	5	0	1 (16,6)	6
Underweight	0	1 (100)	0	1
Asian	**42**	**6**	**3**	**51**
Normal weight	32	6 (11,7)	2 (5)	40
Overweight	8	0	1 (11)	9
Obesity	2	0	0	2
Underweight	0	0	0	0
Total	**981**	**159**	**105**	**1245**

results were not analyzed in detail. However, among caucasians, individuals with overweight or obesity tend to have more cases of EBP or hypertension than the others.

Summary: The association analysis of 2 variables with the BP profile revealed that the elevation of the BP profile is more frequent in girls at a younger age (6-10 years) but then the trend reverses and becomes more common in boys. In any age group the presence of overweight or obesity increases the percentage of cases of altered BP, but the most pronounced changes were observed in the 11-15 years age group. Obese girls have a higher percentage of cases of hypertension. Among the racial groups it was verified that overweight or obese caucasians presented a higher number of cases of hypertension.

Discussion/Conclusions

Assessing the prevalence of BP changes in children is a way of recognizing its existence in this age group and reminds us of the possibilities for intervention to minimize the problem. High blood pressure which appears in childhood, in a high percentage of cases, persists into adulthood [22-25] and it is the main cause of CVD in young adults, a problem associated with high morbidity and mortality worldwide [4,26,27,28].

Characterizing the blood pressure profile of a young population is of great importance in helping to define and implement strategies for diagnosis, therapeutic control and disease prevention. Overall, it can represent an intervention tool at a social, economic and political

level, helping to plan health promotion and disease prevention measures. [28].

In this study, the prevalence of hypertension (8.4%) and HBP (12.8%) is above the European estimate (3-5%)[8] and values published in other studies, but the increase in the number of cases seems to be the current trend [29,30,31,32,33].

However, comparing the prevalence of hypertension in different studies is difficult because there are parameters that can interfere and influence the results presented. Namely: the type of study (school screening or not), the location and environment of the BP assessment (in or out-of-office), the number of measurements taken, the method of BP assessment (auscultatory versus automated) and the criteria for classifying the BP profile, which have changed in recent years. The best way to confirm the changes detected in the blood pressure profile of this sample would be to reassess BP in the consultation room, using the auscultatory and/or oscillometric method [34] and complementing this with Ambulatory blood pressure monitoring (ABPM) for all those who showed an altered profile [8,9].

Age is a variable that influences the blood pressure profile and it has been described that BP values increase with age [8,9]. This was also the trend in this study. The highest percentage of HTN cases occurred in the 16-18 age group (10%), followed by the 11-15 age group and finally the 5-10 age group.

Gender has also been described as influencing factor in the stress profile, with hypertension being more frequent in males [8,9]. In this study, it was the male gender that presented the highest number of cases of hypertension. This difference was particularly accentuated in the 16-18 age group.

Race is referred to as an important and non-modifiable risk factor for BP changes and it has been described that blacks and Asians have a higher risk of developing hypertension [37,38,39,40]. This study found that the Caucasian race had the highest percentage of cases of hypertension, although the vast majority of the participants were Caucasian, which is why the numerical asymmetry in the sample may have influenced the result.

The level of education can be a way of assessing the degree of health literacy, which can depend on the school curriculum, and can influence healthy behaviors and/or alert to risk behaviors for cardiovascular health. It was found that middle and high school students had the highest number of cases of hypertension, contrary to what would be expected, assuming that at this age there is more individual knowledge about healthy lifestyles and risk behaviors (dietary errors, sedentary lifestyle, licit or illicit drug use) [41,42]. This change may correlate with age, but there are other factors that may interfere, such as nutritional status, eating habits, and consumption [41,42]. Furthermore, characteristics of adolescent population, such as little awareness of long-term consequences when making lifestyle choices or preventing risk behaviors, may not reflect higher level of education and knowledge about health.

The increase in hypertension cases in association with overweight and obesity has been well documented. There are several published studies stating that obesity will be one of the main modifiable risk factors that may significantly contribute to the increase in the prevalence of hypertension in the near future [31,43-48]. It has been described that for each unit of increase in the BMI z-score there is a significant increase in blood pressure values [31]. In the study sample 7% of the children were obese and 16% were overweight, confirming the tendency for more cases of EBP and hypertension in obese and overweight children. In the obese population, the percentage of cases of EBP is 16% and hypertension is 26%. In the overweight population, there were 16.6% cases of EBP and 17% cases of hypertension. These values are significantly high when compared to children with normal BMI in which EBP occurred in 11.6% and hypertension in 4.9% of cases.

Analysis of the association effect of different variables (age, gender, race, BMI) on BP values revealed that at any age, any gender or race, the presence of obesity or overweight increases the percentage of hypertension case

Limitations: We can point as limitations of the study the fact that it was conducted in a school setting and that BP was measured using the oscillometric method. Measuring BP in a consultation room (a calm, quiet and peaceful environment) is what is recommended in the guidelines for detecting changes in the BP profile. In this study, measuring BP in a school environment represented the possibility of assessing a greater number of children, but the ideal measurement conditions are more difficult to

achieve in this context. It was not possible in all cases to confirm the changes detected by repeat BP measurement in the consultation office or by ABPM. We acknowledge that these limitations can overvalue our results.

Summary: The prevalence of cases of EBP and hypertension is significant and increases with age. It is more frequent in males, in caucasians (predominant in this sample), in children with higher levels of education (which also corresponds to the older age group) and increases among the obese and overweight population. When the variables are analyzed in association, the effect of each variable on the BP profile is maintained and there is a general increase in cases of BP elevation, especially when there is an association with BMI.

The difference in prevalence of EBP and HTN cases according to different classification criteria reflects the importance of the uniformity of criteria when doing comparative studies across populations.

These results require that the elevation of BP be considered a public health problem, which should be valued from pediatric age, properly identified and addressed in order to improve the quality of life and survival of populations. Promoting education and health literacy among young people, caregivers and health professionals will be necessary. Promoting regular BP surveillance in health surveillance consultations and adopting health promotion measures to control modifiable risk factors such as obesity will be relevant. Early identification, treatment, and appropriate monitoring of those with altered blood pressure profiles is essential. Implementing governmental measures that allow speeding up the whole process from diagnosis to treatment and prevention is essential. Acting early to prevent is key.

Proposals: Improving the identification and referral of cases with altered blood pressure profile (and other CVD risk factors) through careful and regular surveillance within the scope of health surveillance consultations. The data from this study lead us to propose a revision of the current schedule of consultations, increasing the number of consultations for the 11-15 age group.

Promoting health education and literacy among young people, caregivers and health professionals.

Adjusting school curricula. BP elevation is present in children as early as primary school. Obesity, a modifiable risk factor for hypertension, is also present at all education levels. Health education/Health literacy from a young age can contribute to the acquisition of skills that enable better decision making leading to health promotion and CVD prevention. The inclusion of this concept in school curricula, starting from primary school, can contribute to increasing health literacy and improving the quality of life and longevity of populations. In primary school, the proximity between teachers and students facilitates this approach, and schools represent the ideal place to implement health education and literacy, following the principles of equity and social justice. Including this component in school curricula can have a relevant impact on cardiovascular health and global sustainability.

Author Contributions

Carla Simão - Data collection, design and preparation of the article; analysis and interpretation of results; writing of the manuscript, critical review of the content, approval of the final version

Joana Glória - Manuscript writing, version review and critical review of content, approval of the final version

Sara Oliveira - Manuscript writing, version review and critical review of content, approval of the final version

Sofia Deuchande - Data collection, version review and critical review of content, approval of the final version

Margarida Abranches - Data collection, version review and critical review of content, approval of the final version

Filomena Teodoro - Data collection, version review and critical review of content, approval of the final version

Duarte Martins - Data collection, version review and critical review of content, approval of the final version

Susana Correia - Data collection, version review and critical review of content, approval of the final version

Paula Nunes - Data collection, version review and critical review of content, approval of the final version

Cármen Ferreira - Version review and critical review of content, approval of the final version

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Patrícia Mendes - Version review and critical review of content, approval of the final version

Raquel Santos - Version review and critical review of content, approval of the final version

Statement of Ethics

Study approval statement: This study protocol was reviewed and approved by Ethics Committee of Centro Académico de Medicina

de Lisboa, HSM-CHULN (Nº76/16), the Directorate-General of Health, the Directorate-General of Education and the National Data Protection Commission.

Consent to participate statement: The study was also approved by the directors of the school groups involved and all participants gave written informed consent, obtained through the schools from their parents and/or caregivers

Conflict of Interest Statement:

We know of no conflicts of interest associated with this publication. The authors have no conflicts of interest to declare.

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Data Availability Statement

All data generated or analysed during this study are included in this. Further enquiries can be directed to the corresponding author.

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