Original Article

Role of Nutritional and Environmental Factors in the Development of Essential Hypertension among School-going Adolescents in Chennai, Tamil Nadu

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Abstract

Background: Essential hypertension is one of the fastest rising noncommunicable diseases among adolescents and poses a major public health issue globally. This study aimed to estimate the prevalence of prehypertension and hypertension among school-going adolescents in Chennai and also to delineate the role of nutritional and environmental determinants in the development of hypertension. **Methods:** This cross-sectional study was conducted among school-going adolescents aged 14 to 18 years in northern Chennai. Four schools (two private, two public) out of 21 were selected randomly using probability proportionate to sampling size and 401 students were recruited after consent. Data were collected using an adapted modified World Health Organization (WHO) Global School-based student Health Survey (GSHS) questionnaire; anthropometry and blood pressure measurements were done by trained healthcare professionals using standard procedures. Prehypertension was defined when systolic or diastolic pressure >90th percentile and <95th percentile; hypertension when systolic or diastolic pressure >95th percentile. Data were analyzed using SPSS, descriptive statistics like frequencies, mean, and percentages were used and inferential statistics like Chi-square test and logistic regression were used to elicit predictors of essential hypertension. **Results:** Out of 401 participants, 185 (46.1%) were males and 216 (53.9%) were females. Overall prevalence of prehypertension and hypertension was 14.2% and 5.5%, respectively. Gender (P = 0.039), overweight/obese (P = 0.000), junk food intake for >3 days/week (P = 0.000), physical inactivity for <3 days/week (P = 0.000), and parent's history (P = 0.005) were significant determinants in the development of prehypertension and hypertension. **Conclusions:** Nutritional and environmental determinants play a critical role in influencing blood pressure status among adolescents, this requires lifestyle and behavioral modification.

Keywords: *Adolescent, environmental factor, essential hypertension, nutritional, prehypertension*

Introduction

Adolescents represent nearly 17% (over 1.2 billion) of the world's population and constitute nearly 21% of the total Indian population (about 243 million).[1] Lately, there has been an increase in noncommunicable diseases (NCDs) worldwide, which is the major cause of death and disability. Hypertension accounted for 10.7 million deaths and 20.9% of DALYs (Disability Adjusted Life Years) from all risk factors in 2015.[2] Premature deaths due to noncommunicable diseases in India are 21.85% according to World Health Organization (WHO).[3]

Youths are more inclined to NCDs as much as adults nowadays. Essential hypertension is one of the fastest rising noncommunicable diseases among adolescents and poses a major public health issue in both developed and developing countries. The raised blood pressure is frequently observed more in urban than rural areas due to industrialization and the adoption of the western lifestyle.[4] The pooled estimate of adolescent hypertension in India is 7.6%.[5] There's a vast variation in the prevalence of hypertension in south India ranging from 3.6% to 21.4%.[6,7]

Obesity, hypertension, and hypercholesterolemia are more prevalent in Indian school-going adolescents.[8] Consequently, serious cardiovascular complications in adulthood, as the onset of the etiological process and risk behaviors appear in early life.[9]

Monitoring the blood pressure status and early diagnosis among adolescents would help diminish morbidity and mortality in

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adulthood. Since most of these factors like obesity, screen time, sedentary lifestyle, smoking, tobacco chewing, alcohol consumption, physical inactivity, altered sleep pattern, irresolute mental, and emotional behavior[4] are modifiable through lifestyle changes; early diagnosis would arbitrate hypertension among this population. Therefore, the appropriate intervention period is adolescence. With this background, this study was aimed to estimate the prevalence of prehypertension and hypertension among school-going adolescents in Chennai and to demarcate the nutritional and environmental determinants associated with the development of essential hypertension.

Methods

This is a school-based cross-sectional study conducted in four schools (public and private) of North Chennai city administration among adolescents aged between 14 to 18 years old from October 2020 to March 2021. The study was approved by the Institutional Ethics Committee (IRB Approval No: SMC/IEC/2021/03/182).

Sampling and selection of study participants

Selecting four schools was done in a two-step process, at first, a list of schools (both Public and Private) in north Chennai was obtained from the education board of Tamilnadu. Out of 28 schools, only 21 were eligible as our inclusion criteria warranted participants from high and higher secondary classes (9th, 10th, 11th, and 12th standards). Using this sampling frame, four schools (two public and two private) were selected randomly using the probability proportional to size sampling (PPS) method. Recruitment of participants was done after obtaining necessary permissions from the school authorities, four classes with equal probabilities were selected from each school, and all the students were invited to participate in an examination composed of face-to-face interviews, anthropometric analyses, and BP measurements. This method is a variation on multistage sampling in which the probability of selecting a school is proportional to its size and an equal number of students were sampled within each school. A total of 593 students were found to be eligible without any physical or mental disabilities, whether temporary or permanent. The respective teacher of each class was asked to send the detailed information sheet and written consent form to their parents and the response was awaited. Only 401 participants were included in the study after obtaining consent and oral ascent.

Data collection tool

A pretested semistructured questionnaire was used to collect the data using the modified WHO Global School-based student Health Survey (GSHS) questionnaire. It contained four sections, namely, the first being sociodemographic profile followed by nutritional behavior and host and environmental factors, and finally, measurements were obtained. The study measurements are blood pressure and anthropometry were obtained by a trained healthcare professional. Procedural videos and manuals were used to train the investigating team before the commencement of the study using the International Society for the Advancement of Ki anthropometry (ISAK).[10]

Body mass/weight (kg) was measured with a Tanita digital scale, with a range from 0 to 150 kg and a 100 g precision. Seca Aluminium Stadiometer graduated in millimeters with a range from 0 to 2.50 m was used to measure the height (m). Body mass index (BMI) (kg/m^2) using Quetelet index = weight (kg)/height (m^2). Nutritional status was established based on the relationship between weight and height using centers for disease control & prevention CDC-BMI for age standards for adolescents up to 19 years. BMI percentile between 5th to 85th percentile was taken as normal. Those with BMI percentile between 85th percentile and 95th percentile were considered as overweight and above the 95th percentile as obese.[11]

The blood pressure was recorded using a manual mercury sphygmomanometer after the participants rested for 5 min in the right upper arm supported at the heart level in a seated position by auscultation using appropriate cuff size. Systolic blood pressure level was determined by the first Korotkoff sound (K1) and the diastolic BP level was determined by the fifth Korotkoff sound (K5). The average of two measurements 15 min apart was used as the BP measurement for each student. Students with a BP measure that was at the 90th percentile or higher for age and sex had a second screening BP measurement 1 week later.

For the purpose of the study, we identified "Explanatory Variables" such as age, gender, type of school, and followed by Nutritional Factors such as Tobacco and Alcohol Consumption: lifetime tobacco or alcohol use, current tobacco or alcohol use (at least for 5 days during the previous 30 days); Food habits: good dietary habits (intake of fruits, vegetables, whole grains, low-fat dairy products—at least 3 days or more per week) junk food intake (includes salted and unsalted packed foods, carbonated sweetened beverages, red and processed meat products –≥2 days/week). Host and Environmental Factors such as screen time (≥2 h/day), physical activity (≥3 days/week), parent's history (history of hypertension or cardiovascular disease), passive smoking (3 h cut-off per day), and sleep adequacy (≤6 h/day). "Response Variable" for the study was "prehypertension" and "hypertension" among adolescents. According to the American Academy of Paediatrics, Blood pressure levels for adolescents ≥13 years: Normotensive was defined as the systolic pressure (SBP) and diastolic pressure (DBP) <90th percentile; prehypertension when SBP or DBP ≥90th percentile and <95th percentile for age, gender, and height; hypertension when the SBP or DBP ≥95th percentile for age, gender, and height[12]

Statistical analysis

Data normality was tested using Shapiro–Wilk's test. Collected data were entered in MS Office Excel and were analyzed using SPSS, version 21. Qualitative data were expressed as frequencies and percentages. Quantitative data were described using means and standard deviations. Inferential statistics like "Pearson's Chi-square test" were used to associate hypertension and prehypertension with each explanatory variable. Consequently, all significant variables were subjected to multivariate logistic regression analysis to elicit the predictors of prehypertension and hypertension, where P value < 0.05 was taken as statistically significant.

Results

Out of 401 participants, 185 (46.1%) were males and 216 (53.9%) were females. The age range was found between 14 years to 18 years. The mean age was found to be 16.18 ± 1.01 years with 5%, 19%, 37%, 30%, and 9% participants aged 14, 15, 16, 17, and 18, respectively. The overall prevalence of prehypertension and hypertension was 14.2% (n = 57) and 5.5% (n = 22), respectively, as shown in Table 1. The mean systolic blood pressure (SBP) was 111.09 ± 10.76 mmHg and diastolic blood pressure (DBP) was 67.07 ± 8.32 mmHg. Raised SBP and DBP were found in 83 (20.7%) and 39 (9.7%) students, respectively, with prehypertensive SBP in 60 students and hypertensive SBP in 23 students. The mean BMI was 21.33 ± 4.70 kg/m^2. As per BMI classification, 315 (79.15%) were normal, 60 (15%) were overweight, 23 (6%) were obese, and the overall prevalence of overweight/obese was found to be 20.9% (n = 84).

On performing Chi-square test, many nutritional and environmental factors were found to have a significant association with hypertension as shown in Tables 2 and 3. However, variables such as socio economic status (SES), type of school, screen time, and sleep pattern did not have a significant association with the development of essential hypertension among adolescents in this study.

On further analysis to elicit the predictors of essential hypertension among adolescents, all explanatory variables found significant using the Chi-square test were subjected to the multivariate logistic regression [Table 4], and adjusted odd's ratio was derived. P value < 0.005 is considered significant. Nutritional factors like junk food intake and high BMI had 9.33 and 15.83 times higher odds of developing essential hypertension than others significantly in Table 4. Similarly, host and environmental factors like male gender, physical inactivity, and parent's history of hypertension had 2.04, 6.14, and 2.08 times higher odds of developing essential hypertension significantly.

Discussion

Since essential hypertension is multifactorial, a discussion is required to list the individual factors that have been considered to determine their affiliation with the advancement of raised blood pressure and its prevalence among school-going adolescents.

The overall prevalence of prehypertension and hypertension was 14.2% and 5.5%, respectively. The prevalence rate has been so variable across India and different countries. In the Pardede *et al*.[13] In a study done in Indonesia, the prehypertension was 5.1% and hypertension was 9.6%, which is in contrast with our study with lower prehypertension and higher hypertension prevalence. Students in Delhi had 7.3% of prehypertension and 4.3% of hypertension according to Singh *et al*.[14] Tony *et al*.[7] depicted a higher prevalence of prehypertension and hypertension of 21.3% and 21.4%, respectively. Though the

Table 1: Prevalence of prehypertension and hypertension stratified by gender among study participants

Classification	Male		Female		Total	
	n	(%)	*n*	(%)	*n*	(%)
Prehypertension (SBP or DBP ≥90th percentile)	30	7.5	27	6.8	57	14.3
Hypertension (SBP or DBP ≥95th percentile)	14	3.5	8	2	22	5.5
Total	44	11	35	8.8	79	19.8

Table 2: Association of nutritional factors with development of essential hypertension among adolescents

Nutritional factors	Blood pressure	
	Hypertensive	Normal
Good dietary habits		
<3 days/week	56 (22.40%)	194 (77.60%)
≥3 days/week	23 (15.23%)	128 (84.77%)
OR (CI)	1.60 (0.94,2.74)	
Junk food intake		
≥2 days/week	61 (39.61%)	93 (60.39%)
<2 days/week	18 (7.29%)	229 (92.71%)
OR (CI)	8.34 (4.67,14.87)*	
Sweetened carbonated drinks		
≥2 days/week	19 (36.54%)	33 (63.46%)
<2 days/week	60 (17.19%)	289 (82.81%)
OR (CI)	2.77 (1.47,5.20)*	
BMI		
Overweight/obese	55 (63.95%)	31 (36.05%)
Normal	24 (7.62%)	291 (92.38%)
OR (CI)	21.51 (11.73,39.42)*	
Smoking		
>5 days/month	8 (42.11%)	11 (57.89%)
≤5 days/month	71 (18.59%)	311 (81.41%)
OR (CI)	3.18 (1.23,8.20)*	
Alcohol consumption		
Yes	16 (38.10%)	26 (61.90%)
No	63 (17.55%)	296 (82.45%)
OR (CI)	2.89 (1.46,5.70)*	

*P<0.05; considered statistically significant

Table 3: Association of host and environmental factors with development of essential hypertension among adolescents

Host and environmental factors	Blood pressure	
	Hypertensive	Normal
Screen time		
≥2 h/day	42 (24.14%)	132 (75.86%)
<2 h/day	37 (16.30%)	190 (83.70%)
OR (CI)	1.63 (0.99,2.67)	
Passive smoking		
≥3 h/day	25 (16.34%)	128 (83.66%)
<3 h/day	54 (21.77%)	194 (78.23%)
OR (CI)	0.70 (0.41,1.18)	
Physical activity		
<3 days/week	66 (30.00%)	154 (70.00%)
≥3 days/week	13 (7.18%)	168 (92.82%)
OR (CI)	5.53 (2.93,10.43)*	
Adequate sleep		
≤6 h/day	16 (21.92%)	57 (78.08%)
>6 h/day	63 (19.21%)	265 (80.79%)
OR (CI)	1.18 (0.63,2.19)	
Age		
Above average	35 (22.88%)	118 (77.12%)
Below average	19 (19.79%)	77 (80.21%)
OR (CI)	1.20 (0.64,2.25)	
Gender		
Male	48 (25.95%)	137 (74.05%)
Female	35 (16.20%)	181 (83.80%)
OR (CI)	1.81 (1.11,2.95)*	
Type of school		
Private	55 (22.18%)	193 (77.82%)
Public	24 (15.69%)	129 (84.31%)
OR (CI)	1.53 (0.90,2.59)	
Parent's history		
Yes	44 (28.76%)	109 (71.24%)
No	35 (14.11%)	213 (85.89%)
OR (CI)	2.45 (1.48,4.05)*	

*P<0.05; considered statistically significant

Table 4: Multivariate analysis on nutrition and environmental factors to elicit predictors of essential hypertension among adolescents

Risk factors	Blood pressure		
	Adjusted OR (CI)	*P*	b
Nutritional factors			
Junk food intake	9.33 (4.30,20.25)	0.000*	2.234
Sweetened carbonated drinks	1.07 (0.42,2.69)	0.876	0.073
BMI (overweight/obese)	15.73 (7.65,32.35)	0.000*	2.756
Smoking	2.06 (0.40,10.70)	0.386	0.727
Alcohol consumption	0.52 (0.16,1.69)	0.280	-0.650
Host and environmental factors			
Gender (male)	2.04 (1.03,4.03)	0.039*	0.715
Physical inactivity	6.14 (2.63,14.31)	0.000*	1.815
Parent's history	2.80 (4.30,20.25)	0.005*	1.031

*P<0.05; considered statistically significant

present study showed a lower prevalence of hypertension, the prehypertension prevalence was much alarming as it can be considered as a warning sign, which requires immediate intervention.

Our study revealed a higher prevalence among males compared with females. Similarly, the mean SBP (111.09 ± 10.76) and DBP (67.07 ± 8.32) were also higher in males than females corroborating the several other studies in sex differences and raised blood pressure.[15] Sex differences can be attributed to the fact that estradiol and progestin receptors established in vascular endothelium can cause vasodilation.[16]

Deshpande *et al*.[17] found no association with hypertension and junk food intake, whereas this study exhibited frequent junk food intake (≥3 days/week) has been significantly associated with prehypertension and hypertension. Sodium in junk food inflicts increased peripheral vascular resistance, microvascular endothelial inflammation, structural remodeling, and dysfunction.[18]

Our study showed a strong association with the BMI (overweight/obese) and development of hypertension among adolescents as it is consistent with previous studies and global trends.[19,20] Central imbalance in the caloric homeostasis primarily leads to obesity, which increases the arterial intima-media thickness and decreases the nonmediated vasodilator effect directing the development of elevated blood pressure.[21,22]

This study depicted the prevalence of prehypertension and hypertension with smoking and alcohol use, but was not statistically significant, perhaps due to negative effects being apparent only after a prolonged period of smoking and alcohol intake and confounding effect of other variables.

Individuals who engaged in physical activity for less than 3 days per week have a 5% and 2.2% risk of prehypertension and hypertension, respectively. A study conducted in Nagpur (Maharashtra) had similar findings,[17] whereas Mahanta *et al*.[23] indicated detrimental relation between physical activity and hypertension. Regular physical activity of 30–60 min a day will increase the metabolism of lipid and glucose.[24] No relation with screen time ≥2 h/day and sleep patterns were noticed in the present study.

This study was limited to self-reported qualitative data provided verbally by students, which may be a source of recall bias. Routine tests like complete blood count, urinalysis, blood chemistry (potassium, sodium, creatinine, fasting glucose, total and high-density lipoprotein, or HDL cholesterol), and a 12-lead ECG were not performed, as these are hypertension's critical determinants.

Conclusions

This study indicated the prevalence of prehypertension and hypertension among school-going adolescents and also

established the possible risk factors: gender, BMI, junk food intake, and physical inactivity for the development of essential hypertension in adolescents. This can be overcome by school-based interventions: health education to students on a healthy diet with increased fresh fruits and vegetable consumption, low sodium intake, and high fiber diet. For those with a family history of hypertension and high-risk groups, regular tracking, and screening of blood pressure through school health camps must be encouraged. Among those already with hypertension antihypertensive drugs, regular blood pressure monitoring/check-ups, and timely screening for cardiovascular diseases need to be promoted to prevent further complications in adulthood.

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Conflicts of interest

There are no conflicts of interest.

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