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Original Article

Prevalence of Prehypertension and Hypertension and its Determinants among Adolescent School Children of a Semi-urban Area in Erode District, Tamil Nadu

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Abstract

Introduction: As a consequence of industrialization and globalization, the humankind is exposed to great challenges in daily life. Rapid communication and stiff competition everywhere has made the man greatly stressful. Uniquely in the past two decades, children are losing real childhood enjoyments because of parental anxiety and peer group influences.

Objective: The objective of this study is to evaluate the prevalence of prehypertension and hypertension among adolescent school students, and to determine the association of various risk factors with hypertension, in a semi-urban setting of Erode district.

Study Design: A cross-sectional assessment of blood pressure (BP), height, weight was performed in 631 school students (332 - private, 299 - government school) aged 14-17 years. Details regarding physical activity, stress, frequent junk foods intake, mode of transport to school (motor vehicle) was got before the assessment, using a pretested questionnaire.

Results: Among the students, 85.9% had BP in normal range, 14.1% had prehypertension. The mean systolic and diastolic BP in our study was found to be 108.72 and 70.50 mmHg, respectively. There was a significant association between the prevalence of prehypertension and increasing age (adjusted odds ratio [OR] = 3.902 [1.570-9.697]). Male gender (adjusted OR = 2.024 [1.224-3.349]) and increased body mass index (BMI) (adjusted OR = 6.108 [2.953-12.635]) were independent predictors of prehypertension. Other risk factors which had a statistically significant association with prehypertension were frequent junk foods [adjusted OR = 2.141 (1.232-3.722] and stress [adjusted OR = 6.108 (2.953-12.635)].

Conclusion: Increased BMI, along with changing dietary habits are major risk factors for prehypertension in our study population. Stress in school students, as a risk factor for prehypertension is alarming. Hence, routine screening of school children for prehypertension and these risk factors is warranted with initiation of lifestyle modifications for at risk individuals.

Key words: Adolescent school-based, Determinants, Prehypertension, Prevalence

INTRODUCTION

As a consequence of industrialization and globalization, the humankind is exposed to great challenges in daily life. Rapid communication and stiff competition everywhere has made the man greatly stressful. Uniquely in the past two decades, children are losing real childhood enjoyments because of parental anxiety and peer group influences. This may have a negative influence on their health as well. Hypertension is one of the leading causes of death and disability worldwide. Although hypertension is a problem of adults, the etiologic process and risk behaviors start early in life.[1] Studies of societies undergoing acculturation and studies of migrants from a less to more urbanized setting indicate a profound environmental contribution to blood pressure (BP).[2] The prevalence of prehypertension and

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hypertension among children and adolescents is on the increase and underdiagnosed.[3,4] This condition continues into adult hypertension wherein the young adults and youth suffer from cardiovascular and cerebrovascular disorders even before the age of 45 or 40 years.[5-9] This leads to severe morbidity and mortality which in turn causes heavy socioeconomic burden on the society. Keeping in view the seriousness of the problem, this study is undertaken to find out the prevalence of prehypertension and hypertension and its risk factors in school children.

Aim and Objective

The aim and objective of this study is to study the prevalence of prehypertension and hypertension, and its risk factors among adolescent school students in a semi-urban area of Erode district, Tamil Nadu.

METHODS

The study was a cross-sectional, school-based study. After obtaining the Institutional Ethical Committee Clearance, permission from the school authorities and consent from parents were obtained. The study was conducted in three schools (1 - government and 2 - private schools) from Perundurai, Erode District, Tamil Nadu. In our study, 631 students, aged 14-17 years, studying in class 9-12 were included in the study. Among them, 332 students were from private schools and 299 students from government schools. Information of each student was collected in a pretested questionnaire with details of age, sex, class studying, address, duration of physical activity, dietary habits with junk foods, mode of transport to school (motor vehicle or not), and stress. Physical activity was defined as more than 1 h of outdoor activity per day for at least 5 days/week, in the form of play or walk or domestic helps like household chores. Stress was measured on basis of subjective questions such as exam fears, school pressure, peer pressure, family tensions, suicidal tendencies, and loss of close relatives. Junk food was defined as food that has high calories and low nutritional content such as samosa, chips, other fried items, and soft drinks. Increased frequency of junk foods was considered as more than two times in a week.

Height was measured to the nearest 0.5 cm using a non-elastic measuring tape, fastened to a vertical wall, with the student standing on bare feet. Weight was measured with the student on bare feet and with light clothing using electronic weighing balance to the nearest 0.1 kg.

From the height and weight obtained, body mass index (BMI) was calculated using the formula, BMI = Weight (kg)/height (m^2).

A Hawksley random-zero sphygmomanometer was used, for all recordings, with a cuff of appropriate sizes. Readings were taken with the student sitting down and having rested for at least 10 min. Medical interns, who were well trained, took BP measurements in all locations. All BP readings were obtained at a single examination visit. Our study design had access to single BP measurement per survey participant. If the single BP measurement was in prehypertension BP range, it was labeled as prehypertension an approach taken as in Din-Dzietham *et al.*[10] Systemic examination was also done to exclude cardiovascular, renal, and other diseases. Students being adolescents, hypertension was defined according to 7th report of Joint National Committee (Indian Scenario) 2003 for detection, evaluation and treatment of high BP, as systolic BP (SBP) more than or equal to 140 mmHg or diastolic more than or equal to 90 mmHg. Prehypertension was defined as SBP more than or equal to 120 mmHg or diastolic more than or equal to 80 mmHg.[11]

Statistical Analysis

Data entry and analysis of the variables was done using Statistical Package for Social Sciences version 16 software. Descriptive statistics of proportion, mean, standard deviation were calculated for the background characteristics, nutritional status based on BMI and BP level. For analytical statistics, odds ratio (OR) was calculated and Chi-square test was done for test of proportions and student's *t*-test for test of means. Logistic regression was done to find the adjusted OR for association of various background characteristics with prehypertension. Variables which had $P \leq 0.20$ were included in the model. Those with $P \leq 0.05$ was considered statistically significant.

RESULTS

There were a total of 631 students. Table 1 gives the background characteristics of the group studied. Majority of the students were in 16 years age group followed by 15 years age group. The least number of students were in 17 years age group.

The mean SBP and diastolic BP (DBP) for age 14 were 104.90 mmHg (standard deviation ± 10.5) and 67.66 mmHg (± 8.35), age 15 were 108.31 mmHg (± 11.27) and 70.75 mmHg (± 7.82), age 16 were 110.31 mmHg (± 11.91) and 71.35 mmHg (± 8.93), and age 17 were 111.83 mmHg (± 14.40), 72.70 mmHg (± 9.84). The mean BP was found to be increased significantly with age ($P < 0.01$) as shown in Table 2.

Males had a mean SBP and DBP of 109.81 (± 13.12) and 71.45 (± 8.92) mmHg, respectively. Mean SBP and DBP among females were 107.67 (± 10.58) and

69.58 (± 8.52) mmHg. Males had a significantly higher mean BP as compared to females (*P* value for SBP 0.03 and DBP 0.01). The mean SBP and DBP of government schools were almost similar. The difference was not statistically significant (*P* value for SBP 0.46 and DBP 0.56).

In this study, the prevalence of prehypertension was found to be 81 (12.83%) and that of hypertension was found to be 8 (1.26%) among school children of ages 14-17 (Figure 1). As the group of hypertensive students was too small to compare with normotensive students, we have combined the hypertension and prehypertension students into a single group for cross tabulation in our study.

The percentage of adolescents with prehypertension was highest in 17 years age group (23.9%) and least in 14 years age group (7.7%). Prehypertension was found to be increasing with increasing age, and this association was statistically significant ($P = 0.008$) (Table 3).

The risk of prehypertension was found to be higher in males (17.1%), compared to females (11.1%) and this difference was statistically significant ($P = 0.029$).

Table 1: Background characteristics

Background characteristics	*n* (%)
Age in years	
14	142 (22.5)
15	166 (26.3)
16	252 (39.9)
17	71 (11.3)
Sex	
Male	315 (49.9)
Female	316 (50.1)
Type of school	
Government	299 (47.4)
Private	332 (52.6)
Total	631 (100.0)

As compared to government schools, private schools had more number of prehypertensive students ($P = 0.010$). The prevalence of prehypertension was higher among individuals with increased BMI with significant $P < 0.001$.

Mode of transport to school by motor vehicle ($P = 0.025$) and physical activity of <1 h/day ($P = 0.094$) were not associated with the prevalence of prehypertension.

Students with stress were found to be more prehypertensive than normal students, $P = 0.004$.

The proportion of prehypertension was more among students with frequent junk foods intake, but the $P = 0.087$ was insignificant.

Logistic regression analysis (Table 4) revealed older age (adjusted OR = 3.902 [1.570-9.697]; $P = 0.003$], male sex (adjusted OR = 2.024 [1.224-3.349]; $P = 0.006$), and increased BMI (adjusted OR = 6.108 [2.953-12.635]; $P < 0.001$) were independent risk factors for prehypertension. There was no significant association between private schools and prehypertension after adjustment in the regression model.

Stress (adjusted OR = 1.807 [1.097-2.978]; $P = 0.020$) and frequent intake of junk foods (adjusted OR = 2.141 [1.232-3.722]; $P = 0.007$) were associated with prevalence of prehypertension even after inclusion in the regression model with statistical significance.

DISCUSSION

Prehypertension and hypertension in pediatrics is largely underestimated, underdiagnosed[3,4] and hence untreated. Essential hypertension in adults is found to have its roots in childhood and adolescence.[5,12-15] Hence, early recognition

Table 2: Mean weight, height, BMI and BP of students

Background characteristics	*n*	Mean±SD				
		Weight	Height	BMI	Systolic BP	Diastolic BP
Age in years						
14	142	39.54±8.067	151.55±7.874	17.1357±2.7	104.90±10.5	67.66±8.35
15	166	42.86±8.82	157.72±8.95	17.1728±2.71	108.31±11.27	70.75±7.82
16	252	47.26±9.62	161.79±8.80	18.0699±3.29	110.31±11.91	71.35±8.93
17	71	51.11±10.32	164.28±9.28	19.1070±3.92	111.83±14.40	72.70±9.84
P value		<0.01*	<0.01*	<0.01*	<0.01*	<0.01*
Sex						
Male	315	45.86±10.85	162.31±10.26	17.3081±3.048	109.81±13.12	71.45±8.92
Female	316	43.74±8.71	155.09±7.59	18.1712±3.22	107.67±10.58	69.58±8.52
P value		<0.01*	<0.01*	<0.01*	0.03*	0.01*
Type of school						
Government	299	41.42±8.36	155.30±8.92	17.1258±2.79	108.37±10.92	70.30±8.31
Private	332	47.85±10.17	161.76±9.39	18.2938±3.37	109.07±12.83	70.70±9.17
P value		<0.01*	<0.01*	<0.01*	0.46	0.56

*$P<0.05$. BP: Blood pressure, BMI: Body mass index, SD: Standard deviation

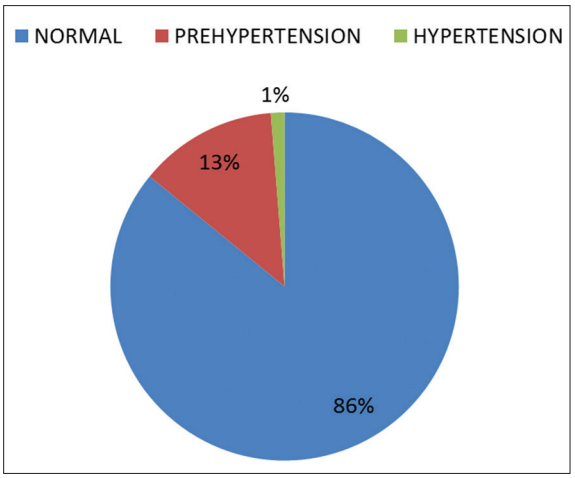

Figure 1: Prevalence of elevated blood pressure

of adolescents with prehypertension and hypertension aid in the initiation of lifestyle modifications, thereby preventing morbidity and mortality among adults.

In our study, 81 (12.83%) students were found to have prehypertension and 8 (1.26%) had hypertension. In a study conducted by McNiece *et al.* on 6790 adolescents (11-17 years), the prevalence of prehypertension was reported as 15.7%, Stage I hypertension as 2.6% and Stage II hypertension as 0.6%.[14] Patil and Garg in their study, on prevalence of hypertension had a prevalence of 3%.[16] While in a study done by Bute *et al.* at rural area of Indore, the overall prevalence of hypertension among adolescents was 5.25% and prehypertension was 17.4%.[17] Other studies done in different parts of India reported a vast range in the prevalence of hypertension in children and adolescents showing as high as 21.5% to as low as 3.67%.[18,19] The prevalence of hypertension was 10.1% and prehypertension was 20.7% among school going children in Congo, the study by Mbolla *et al.*[20] The variations in the percentage of prehypertension and hypertension may be attributed to the difference in geographical location, sociocultural and socioeconomic backgrounds.

In our study, the mean increase in SBP and DBP was found to rise significantly with increase in age ($P > 0.01$). This spurt in BP is attributed to certain biological and psychological factors in puberty.[21,22] Older age is found to be significantly associated with prehypertension (adjusted OR = 3.902 [1.570-9.697]; $P = 0.003$). Borah *et al.*, in their study on hypertension in school children in North East India, also had significant association of older age and hypertension.[23]

Male gender had more number of prehypertension than females ($P = 0.029$). Furthermore, male sex was found to be an individual risk factor for prehypertension in our study (adjusted OR = 2.024 [1.224-3.349]; $P = 0.006$). Fallah *et al.*, in their study on prehypertension and

Table 3: Prevalence of prehypertension by age, sex, types of school, BMI and other factors

Background characteristics	*n*	*n* (%)		*P* value
		Normal BP	Pre hypertension	
Total	631	542 (85.9)	89 (14.1)	
Age in years				0.008
14	142	131 (92.3)	11 (7.7)	
15	166	146 (88.0)	20 (12.0)	
16	252	211 (83.7)	41 (16.3)	
17	71	54 (76.1)	17 (23.9)	
Sex				0.029*
Male	315	261 (82.9)	54 (17.1)	
Female	316	281 (88.9)	35 (11.1)	
Type of school				0.010*
Government	299	268 (89.6)	31 (10.4)	
Private	332	274 (82.5)	58 (17.5)	
BMI				
Underweight	165	161 (97.6)	4 (2.4)	<0.001*
Normal	427	363 (85.0)	64 (15.0)	
Overweight/obese	39	18 (46.2)	21 (53.8)	
Stress				
Yes	248	201 (81.0)	47 (19.0)	0.004*
No	383	342 (89.3)	41 (10.7)	
Mode of transport to school (motor vehicle)				
Yes	510	442 (86.7)	68 (13.3)	0.253
No	121	100 (82.6)	21 (17.4)	
Low physical activity(<1 h/day)				
Yes	174	156 (89.7)	18 (10.3)	0.094
No	457	386 (84.5)	71 (15.5)	
Frequent Junk foods(>2 times/week)				
Yes	153	125 (81.7)	28 (18.3)	0.087
No	478	417 (87.2)	61 (12.8)	

P<0.05. BP: Blood pressure, BMI: Body mass index

Table 4: Logistic regression analysis for association of background variables and prehypertension

Background characteristics	Unadjusted OR	Adjusted OR	95% CI for Adjusted OR	*P* value
Age in years				
14	1	1		
15	1.631	2.132	0.940-4.831	0.070
16	2.314	2.473	1.171-5.227	0.018*
17	3.749	3.902	1.570-9.697	0.003*
Sex				
Female	1	1		
Male	1.661	2.024	1.224-3.349	0.006*
Nutritional status				
Normal weight	1	1		
Overweight and obesity	7.096	6.108	2.953-12.635	<0.001*
Stress	1.945	1.807	1.097-2.978	0.020*
Frequent Junk foods	0.653	2.141	1.232-3.722	0.007*

**P*<0.05. CI: Confidence interval, OR: Odds ratio

hypertension on Iranian children documented significant gender difference in the frequency distribution of high BP, with higher prevalence rates of prehypertension and hypertension in boys than in girls.[24] Similarly, Michalsky *et al.*, in their study, on cardiovascular risk factors among adolescents found elevated BP (adjusted relative risk = 1.48 [95% confidence interval: 1.16-1.89]; $P < 0.01$) were more likely in adolescent boys compared with adolescent girls.[25] Testosterone, which increases during puberty, is proposed to lower the natriuretic peptide, and therefore, leads to the postpubertal increase of BP in boys.[26]

The mean BMI was significantly reported higher with increasing age ($P < 0.01$), female gender ($P < 0.01$), and private schools ($P < 0.01$). Furthermore, there was a significant association of increased BMI with prehypertension (adjusted OR = 6.108 [2.953-12.635]; $P < 0.001$). There are several studies in literature with results showing significant association of increased BMI with prehypertension and hypertension.[27,28,31]

Mode of transport to school by motor vehicle did not make any statistical difference in the occurrence of prehypertension. The proportion of prehypertension in adolescents with low physical activity was not significantly high when compared to normal subjects ($P = 0.094$). This is in contrast to the study by Bute *et al.*, with a significant association of low physical activity with prehypertension and hypertension.[17] This may be due to the difference in the duration of physical activity taken in the study. Our study had a limit of 1 h/day for low physical activity, but other comparable studies had 1/2 h/day. Hence, there is a chance of including even adolescents with moderate physical activity into this group and thereby diluting the results.

Significantly, prehypertension was more frequently observed among adolescents with stress (adjusted OR = 6.108 [2.953-12.635] $P = 0.020$). Moussa *et al.* had observed a significant association of stress with hypertension among undergraduate students.[29]

Furthermore, intake of junk foods had significant association with prehypertension (adjusted OR = 2.141 [1.232-3.722]; $P = 0.007$]. In a similar study carried out in Bihar, among 5-19 years adolescents, by Kumar *et al.*, hypertension was significantly associated with type of diet ($P < 0.001$).[30] Several studies conducted in Kerala also had similar associations between junk foods and prehypertension.[31,32]

Limitations

Our study had some limitations. Classification of hypertension was based on measurement of BP in a single visit. It is recommended that students with BP >95th percentile on first screening should undergo a second screening 1-2 weeks later and then the third screening if BP is noted >95th percentile at the second screening. Due to academic engagements and administrative issues, we could not practice the second and third screening.

CONCLUSION

In our study, the prevalence of prehypertension and hypertension among school children in a semi-urban area is 14.01%. Increasing age, male sex, overweight and obesity, stress, and junk foods were independent risk factors for prehypertension. Hence, it would be logical to advise schools to carry out daily physical education sessions for at least one period of their daily schedule with emphasis on yoga and education on healthy nutritional habits to maintain normal BMI among students. In addition, we recommend screening of school children for high BPs yearly. Special sessions to tackle with stress are warranted in schools.

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