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Original Research Article

Prevalence of hypertension and its risk factors among high school children in Bangalore, India

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ABSTRACT

Background: Hypertension is a prominent health disorder that leads to 12.8% of deaths worldwide. Although predominantly considered a disorder of the adults, the roots of hypertension start from childhood. In the past children usually suffered from secondary hypertension. However, now with increased incidence of obesity, reduced physical activity, unhealthy dietary habits, use of tobacco and alcohol among adolescents there is now an increased prevalence of primary hypertension in this age group. The present study was conducted with the objective of assessing the prevalence of hypertension and its modifiable risk factors in high school children.
Methods: The study was conducted among high school students aged 13 to 16 years in urban Bangalore. A self-administered questionnaire was used to assess the lifestyle. Age, sex, height, weight and resting blood pressure were recorded. Odds ratio, Chi square test and logistic regression were used in the analysis.
Results: There were 550 students who participated in the study, 300 (54.54%) were males and 250 (45.45%) were females. The prevalence of prehypertension was 21.6% and hypertension was 8.9%. Logistic regression revealed that overweight, obesity, high salt intake, tobacco use, and stress were significantly associated with elevated blood pressure.
Conclusions: There is a rise in the prevalence of hypertension among high school students. Changes in lifestyle seem to influence the development of hypertension in this age group. Behaviour change communication should be used to reduce the modifiable risk factors and promote healthy lifestyle among adolescents.

Keywords: Adolescents, Hypertension, Pre-hypertension, Prevalence, Risk-factors

INTRODUCTION

Adolescents belong to the age group 10 to 19 years and they are transitioning from childhood to adulthood. The population of adolescents in the world is estimated at 1.2 billion.[1] India makes up for a fifth of this with 253 million adolescents.[2] This large body of children will soon be the youth of the nation with bright ideas and brilliant prospects. Therein lies the future of the country. Adolescence is a unique period, while the body develops before gaining psychosocial maturity. This leads to experimentation. The adolescents' physical capabilities, their explorative sense, impulsivity and capacity for self-control do not go hand-in-hand. This is the basis for some of the problem-behaviors and risk-behaviors which are followed by health problems.[3,4]

Behaviors such as unhealthy diet, sedentary lifestyle leading to obesity, use of tobacco and alcohol increase the risk of dying from non-communicable diseases (NCDs). Cardiovascular diseases already account for the deaths of

17.7 million people annually.[5] Hypertension is a common biological risk factor for cardiovascular diseases. High systolic blood pressure accounted for 10.4 million deaths and 218 million global disability adjusted life years (DALYs).[6] Prevalence of hypertension in India is 29.8% among adults.[7] Although predominantly considered a disorder of the adults, it has been found that elevated blood pressure in adolescence can be tracked to high blood pressure in adulthood.[8,9] Many studies are available for prevalence of hypertension in adults. However, there are very few studies among Indian adolescents. Therefore, the present study was conducted to assess the prevalence of hypertension and its risk factors among high school adolescents.

METHODS

The study was conducted among school children in the high schools situated in the field practice area of a medical college. It was a cross-sectional study and the data were collected in three months from February to April 2017, after obtaining the ethical clearance from Institutional Ethics Committee. All school students who were studying in 8th and 9th standards who were willing to participate and whose parents had consented were included in the study. Students who were on medications that are known to influence blood pressure and students with secondary hypertension were excluded from the study. Based on 15% prevalence of prehypertension and hypertension in school children sample size was calculated as 544 with an absolute precision of 3% at an α level of 5%.[10] As this study was a part of a larger interventional study with multiple visits, a correction for 5% drop out was allowed. Out of a total of 575 students who participated in the study, 550 students completed their questionnaires and were thus included in the analysis. The data were collected from the participants of 6 schools, of which 3 were government-run and 3 were private high schools. Each school was given a 3-letter code. Students were allotted sequential numbers along with their date of birth and gender to generate a unique code to maintain anonymity. A pretested semi-structured self-administered questionnaire was used to assess their practices regarding hypertension and its risk factors. The questionnaire comprised of sections for recording demographic details, anthropometric measurements, systolic and diastolic blood pressure, physical activity, fruit and vegetable intake, salt intake, sleep duration, Cohen's 10 item Perceived Stress Scale (PSS), tobacco use and alcohol use. Blood pressure was measured with the participant sitting upright and right hand resting on table using Omron electronic sphygmomanometer. The manometer was calibrated against a standard mercury manometer every morning. Three readings were taken at 0, 5 and 30 minutes. An average of the last two readings was used to calculate the final blood pressure. The blood pressure was classified based on the Indian Academy of Pediatrics recommendations for prehypertension and hypertension in children using the nomogram tables for height and blood pressure percentiles.[11] Weight was measured using an electronic weighing machine without footwear and minimal clothing. Height was measured with a standard stadiometer, without footwear and taking all standard precautions. The body mass index (BMI) was calculated and used to categorize the adolescents as normal, overweight or obese based on the IAP Guidelines.[12] Physical activity details were collected as number of days of moderate to vigorous physical activity in a week and number of minutes of physical activity during these days. The average number of minutes of physical activity per day was calculated. Physical activity of less than 60 minutes was categorized as inadequate, based on WHO recommendations.[13] Salt intake was assessed based on number of days they had food like pickles, papads, chips and fries. Fruits and vegetables less than 400 grams (5 serving) as prescribed in DASH diet was considered as inadequate.[14] Based on the National Sleep Foundation recommendations, sleep duration of less than 8 hours was considered as inadequate.[15] Cohen's Perceived Stress Scale was used to measure the stress among the adolescents.[16] Students with scores above the 95th Percentile were categorized as having high stress. Overall use of tobacco, smoking and non-smoking type together, was evaluated. They were also asked if they ever consumed alcoholic beverages. Participants were reassured of their anonymity and asked to answer the questions honestly.

The data were entered into Microsoft Access 2016 and further statistical analysis was done using Statistical Package for Social Sciences, version 21 and Epi Info for Android, build 1.2.5.

All demographic variables were represented using percentages. Normally distributed continuous variables were described using Mean±Standard Deviation. Non-normally distributed continuous variables and discrete variables were described as Median and Inter-Quartile Range (IQR). Continuous and discrete variables were categorized or dichotomized for analysis of association. Odd's Ratio was calculated for the risk factors. The association between risk factors and hypertensive status was analysed using Chi Square test/Fisher's Exact test. All significant associations were further analysed with binary logistic regression.

RESULTS

The responses of 550 students who had participated and completed all the sections of the questionnaire were considered for the analysis. Among the 550, 180 (32.7%) students were aged 15, 145 (26.4%) were 14 years old, 143 (26%) students were 13 years old and 82 (14.9%) 16 years old. There were 300 (54.5%) males and 250 (45.5%) females in the study.

Students from government schools were 274 (49.8%) and 276 (50.2%) were from private schools. Table 1 shows the distribution of the anthropometric measurements of

the study population and the number of students according to age and gender.

The overall prevalence of elevated blood pressure was 30.5%. As seen in Figure 1, prehypertension was found in 119 (21.6%) of the adolescents, while 49 (8.9%) had hypertension. The prevalence of prehypertension and hypertension among age, gender and type of school is given in Table 2. There was no significant association between them.

Obesity was seen in 2.18% of the students and 39.6% of the students were overweight. 14.2% of the overweight were hypertensive and 33% were prehypertensive. 25% of the obese students were hypertensive and 16.7% were prehypertensive. 63.3% of the hypertensive and 60.5% of the prehypertensive students were overweight.

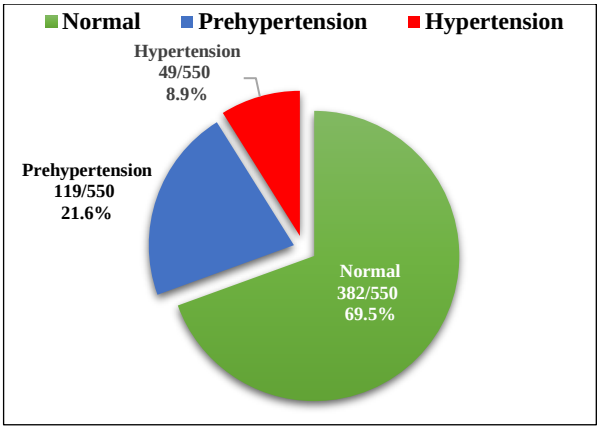

Figure 1: Distribution of study subjects according to blood pressure categories (n=550).

Table 1: Distribution of anthropometric characteristics according to age and gender presented as mean±SD.

Age (years.)	Gender (n)	Height (cm)	Weight (kg)	BMI (kg/m^2)	Waist circumference (cm)	Waist-hip ratio
13	Male (64)	156.0±8.7	50.1±7.0	20.7±2.3	71.1±4.4	0.79±0.03
	Female (79)	153.4±6.0	49.6±6.0	21.1±2.3	72.6±5.5	0.81±0.04
14	Male (78)	158.5±7.8	51.3±7.1	20.5±2.3	71.9±4.9	0.81±0.05
	Female (67)	151.0±3.0	48.8±5.4	21.3±2.0	71.4±4.7	0.81±0.04
15	Male (103)	163.8±7.2	54.2±5.6	20.3±2.0	71.2±3.2	0.78±0.03
	Female (77)	154.3±5.8	50.1±6.0	21.1±2.2	70.5±3.5	0.81±0.54
16	Male (55)	168.9±5.4	56.8±7.0	20.0±2.4	71.8±3.6	0.8±0.035
	Female (27)	156.0±5.8	50.2±6.0	20.7±2.2	70.4±3.3	0.82±0.04

Table 2: Prevalence of elevated blood pressure among study subjects based on demographic categories (n=550).

Demographic categories		N	Normal BP number (%)	Prehypertension number (%)	Hypertension number (%)	P value
Gender	Male	300	208 (69.3)	64 (21.3)	28 (9.3)	0.922
	Female	250	174 (69.6)	55 (22)	21 (8.4)	
Age (yrs)	13	143	91 (63.6)	38 (26.6)	14 (9.8)	0.256
	14	145	97 (66.9)	37 (25.5)	11 (7.6)	
	15	180	135 (75)	29 (16.1)	16 (8.9)	
	16	82	59 (72)	15 (18.3)	8 (9.8)	
Type of school	Government	274	194 (70.8)	57 (20.8)	23 (8.4)	0.677
	Private	276	188 (68.1)	62 (22.5)	26 (9.4)	

Inadequate physical activity was reported by 94.9% of the students while 94.36% reported inadequate consumption of fruits and vegetables per day. Inadequate sleep duration was reported by 65.45% of the students and 17.45% reported high salted-food intake. Alcohol consumption was reported by 2.18% and 7.8% reported use of tobacco in any form. The median stress score for students with elevated BP was 19 (16-23) which was significantly higher than that of normotensive students where it was 17 (15-20). There were 34 (6.18%) students with perceived stress scores more than the 95th percentile value, i.e. beyond 2SD of the population. The prevalence of all the risk factors that were studied and their age- and gender-wise distribution is depicted in Table 3. The present study revealed that overweight and obesity, increased salted food consumption, inadequate sleep duration, high perceived stress score, tobacco use and alcohol consumption were all significantly associated with elevated blood pressure ($p<0.01$) as shown in Table 4.

Logistic regression analysis showed that BMI, high salt intake, tobacco use and perceived stress were significant predictors of elevated blood pressure. The adjusted odds with 95% CI are given in Table 5.

Table 3: Prevalence of modifiable risk factors distributed according to gender and age (n=550).

Risk factors		Gender		χ^2	Age				χ^2	N (%)
		Male	Female	P value	13	14	15	16	P value	
		N (%)	N (%)		N (%)	N (%)	N (%)	N (%)		
BMI	Obese	11 (3.7)	1 (0.4)	0.013*	11 (7.7)	1 (0.7)	0	0	<0.0001*	12 (2.2)
	Overweight	111 (37.0)	107 (42.8)		69 (48.3)	73 (50.3)	56 (31.1)	20 (24.4)		218 (39.6)
	Normal	178 (59.3)	142 (56.8)		63 (44.1)	71 (49.0)	124 (68.9)	62 (75.6)		320 (58.2)
Physical activity (P.A.)	Inadequate P.A.	283 (94.3)	239 (95.6)	0.5	137 (95.8)	137 (94.5)	172 (95.6)	76 (92.7)	0.732*	450 (81.8)
	Adequate P.A.	17 (5.7)	11 (4.4)		6 (4.2)	8 (5.5)	8 (4.4)	6 (7.3)		100 (18.2)
Salted food consumption	Increased	46 (15.3)	50 (20.0)	0.15	31 (21.7)	27 (18.6)	24 (13.3)	14 (17.1)	0.257	96 (17.5)
	Normal	254 (84.7)	200 (80.0)		112 (78.3)	118 (81.4)	156 (86.7)	68 (82.9)		454 (82.5)
Fruit and vegetable consumption	Inadequate	286 (95.3)	233 (93.2)	0.28	135 (94.4)	139 (95.9)	167 (92.8)	78 (95.1)	0.698*	519 (94.4)
	Adequate	14 (4.7)	17 (6.8)		8 (5.6)	6 (4.1)	13 (7.2)	4 (4.9)		31 (5.6)
Sleep duration	Inadequate	189 (63.0)	171 (68.4)	0.208	91 (63.6)	100 (69.0)	112 (62.2)	57 (69.5)	0.488	360 (65.5)
	Adequate	111 (37)	79 (31.6)		52 (36.4)	45 (31.0)	68 (37.8)	25 (30.5)		190 (34.5)
Perceived stress score	>95th Percentile	18 (6.0)	16 (6.4)	0.846	13 (9.1)	12 (8.3)	6 (3.3)	3 (3.7)	0.086*	34 (6.2)
	≤95th Percentile	282 (94.0)	234 (93.6)		130 (90.9)	133 (91.7)	174 (96.7)	79 (96.3)		516 (53.8)
Tobacco use	Present	40 (13.3)	3 (1.2)	<0.0001*	2 (1.4)	11 (7.6)	16 (8.9)	14 (17.1)	<0.0001*	43 (7.8)
	Absent	260 (86.7)	247 (98.8)		141 (98.6)	134 (92.4)	164 (91.1)	68 (82.9)		507 (92.2)
Alcohol consumption	Present	12 (4)	0	0.001*	0	2 (1.4)	7 (3.9)	3 (3.7)	0.044*	12 (2.2)
	Absent	288 (96)	250 (100)		143 (100)	143 (98.6)	173 (96.1)	79 (96.3)		538 (97.8)

*Fisher's Exact test.

Table 4: Association of the modifiable risk factors with elevated blood pressure.

Risk factors		Elevated BP	Normal BP	Total	P value@	Odds ratio (95% CI)
		N (%)	N (%)			
BMI	Obese	60 (18.75)	260 (81.25)	320	<0.0001	3.84 (2.62-5.62)
	Overweight	103 (47.25)	115 (52.75)	218		
	Normal	60 (18.75)	260 (81.25)	320		
Physical activity (P.A.)	Inadequate P.A.	159 (30.5)	363 (69.5)	522	0.85	0.92 (0.4-2.08)
	Adequate P.A.	9 (32.1)	19 (67.9)	28		
Salted food consumption	Increased	65 (67.7)	31 (32.3)	96	<0.0001	7.14 (4.42-11.56)
	Normal	103 (22.7)	351 (77.3)	454		
Fruit and vegetable consumption	Inadequate	158 (30.44)	361 (69.56)	519	0.831	0.9 (0.41-1.96)
	Adequate	10 (32.26)	21 (67.74)	31		
Sleep duration	Inadequate	123 (34.2)	237 (65.8)	360	0.011	1.67 (1.12-2.49)
	Adequate	45 (23.7)	145 (76.3)	190		
Perceived stress score	>+2SD	24 (70.6)	10 (29.4)	34	<0.0001	6.2 (2.89-13.28)
	≤+2SD	144 (27.9)	372 (72.1)	516		
Tobacco use	Present	28 (65.1)	15 (34.9)	43	<0.0001	4.89 (2.54-9.44)
	Absent	140 (27.6)	367 (72.4)	507		
Alcohol consumption	Present	10 (83.3)	2 (16.7)	12	0.0002	12.03 (2.6-55.5)
	Absent	158 (29.4)	380 (70.6)	538		
Total		168	382	550		

@Chi-square test

Table 5: Logistic regression analysis of modifiable risk factors of hypertension.

Variables (Risk Factors)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	P value
BMI (>normal)	3.84 (2.62-5.62)	2.516 (1.652-3.831)	<0.0001
High salt intake	7.14 (4.42-11.56)	4.761 (2.822-8.305)	<0.0001
Alcohol use	12.03 (2.6-55.5)	1.282 (0.210-7.809)	0.765
Tobacco use	4.89 (2.54-9.44)	2.196 (1.071-4.994)	0.033
Inadequate sleep	1.67 (1.12-2.49)	1.309 (0.842-2.035)	0.220
High perceived stress	6.2 (2.89-13.28)	1.702 (1.095-2.647)	0.018

DISCUSSION

The prevalence of hypertension in the study was 8.9%. Some of the other Indian studies have reported a similar prevalence. Soudarssanane et al from Puducherry have reported a prevalence of hypertension among adolescent school children to be 9.4%.[17] Sharma et al in a study on school children from Shimla have reported a prevalence of hypertension in 7.1% Urban students.[18] Borah et al reported 7.6% hypertension in school children from Dibrugarh.[19] A recent study by Bala et al reported a prevalence of hypertension to be 13% in a cohort of adolescent school students in Hyderabad.[20] A 2014 study by Patel et al from Bhopal had shown a 5.36% prevalence of hypertension.[21] The prevalence of prehypertension was 24.11% among the adolescents of Gangtok in a study by Kar et al.[22] In a study conducted on school adolescents in Delhi by Anand et al, the prevalence of prehypertension was 30.1%, which was higher than 21.6% seen in this study.[23] But that study was conducted in a single school and included students from 12 to 17 years of age.

Although the sample size of the present study was calculated based on the study by Kumar et al where prevalence of prehypertension and hypertension was 15%, the present study showed a prevalence of 30.5%.[11] Many earlier studies reported lower levels of elevated blood pressure, while the more recent studies show higher prevalence. The higher prevalence could be because of the various lifestyle factors that the children are exposed to in the present times. The society is slowly shifting from communicable to non-communicable ailments. This is also reflected in the health status of the adolescents who are the latest adopters of the adult lifestyle. The varying prevalence could also be due to the different age groups taken for various studies, different criteria adopted for defining hypertension, variations in the dietary and cultural factors.

A study by Hemalatha et al documents the prevalence of obesity to be 2.2% among the adolescent school children, which is similar to this study.[24] Kar et al also found the prevalence of obesity to be 2.04%.[22] Mohan et al showed the prevalence of obesity to be 2.35%. Of the 11.63%

overweight children, 15% were hypertensive; whereas 43% of the obese children were hypertensive.[25] In the study by Patel et al 25% of the obese were hypertensive.[21] Thus, the increasing prevalence of overweight and obesity also has an adverse influence on hypertension. Results obtained after Binary logistic regression analysis also showed a strong independent association of increased BMI with elevated blood pressure.

WHO recommends moderate to vigorous physical activity of at least 60 minutes per day for adolescents? It reported a high trend of 81% prevalence of insufficient physical activity globally among school going adolescents.[13] Other Indian studies have reported a much lower prevalence. Singh et al also reported a low prevalence of physical activity of 20% in their study on the lifestyle risk factors in adolescents.[9] Bala et al in their study reported the prevalence of insufficient physical activity to be 62%.[20] Varying levels of prevalence may be attributed to the different methods of assessment and criteria used. While this study used a self-reported tool to assess physical activity duration, a directly observed structured study may yield better results.

This study found a prevalence of 17.5% for high frequency of salted food intake. Kumar in a study in Patna found 22.3% were taking extra salts.[26] Soudarssanane et al in their study among adolescents and young adults in Puducherry found that, dietary salt significantly affects mean DBP but not mean SBP.[17] A more concerted and assertive action needs to be taken up by educating the parents and decision makers to help prevent the high consumption of salt.

A low frequency and quantity of fruit and vegetable consumption was seen in 94.4% of the students. Among the hypertensives, 91.8% and 95% of the prehypertensive were consuming less fruits and vegetables than recommended by WHO, which is 400 gms of fruits and vegetables per day. Kumar et al in their study found that 35.6% of the adolescents did not consume any fruits in the previous week.[26] Singh et al found that 60.6% of the students were not consuming fruits on a regular basis.[9] A study by Prajapati et al used the same cut off for adequate fruit and vegetable consumption (>400 gm/day) and their results showed a similar prevalence of inadequate consumption at 93.11%.[27]

Tobacco use has for long been associated with elevated blood pressure. In the present study the prevalence of tobacco use was found to be 7.8%. It also had higher odds of leading to hypertension, 4.89 (95% CI of 2.54-9.44). On binary logistic regression there was independent odds of 1.96 (1.07-4.99), which is still high. The study by Kumar et al found the prevalence to be 8.3% among the adolescent boys.[26] According to India Global Youth Tobacco Survey (GYTS) 2009 the prevalence of use of any type of tobacco product was 14.6% among 13-15 years age group, which was almost double of that in the present study.[28]

Use of alcohol was seen in 2.2% of the students. There was a significant association with hypertension ($p<0.0001$) and an Odds Ratio of 12.03 (95% CI: 2.6-55.5). Studies by Soudarssanane et al (1.7%) and Kumar et al (2.1%) showed a similar low prevalence.[17,26] But studies by Singh et al (28%) and Jaisoorya et al (15%), report much higher rates of prevalence.[9,29]

Stress has been linked with elevated blood pressure across many studies. While Cohen's perceived stress scale is a simple self-administered tool with a high validity and good sensitivity, there are many other tools available which have been used in the other studies.[16,19,9] High perceived stress scores had 1.7 times odds of raising the blood pressure after adjustment. There was a significant positive correlation between systolic BP and perceived stress score among those with elevated blood pressure ($\rho=0.347$, $p<0.0001$). There was also a significant negative correlation between diastolic BP and perceived stress score ($\rho=-0.185$, $p=0.017$).

Reduced sleep duration was seen in 65.5% of the students in the present study. In the study, by Shaikh WA et al, it was 29% in Gujarati adolescents. However, the study categorized sleep duration as less than 7 hrs, 7-8 hrs and more than 8 hrs.[30]

The overall prevalence of elevated blood pressure was 30.5%. Prehypertension was found in 21.6% of the adolescents, while 8.9% had hypertension. Overweight and obesity, high salt intake, tobacco use, and stress were significantly associated with hypertension.

CONCLUSION

Lifestyle changes influence the development of modifiable risk factors in adolescents. Given the burden of non-communicable diseases in a developing country like India, the prevention of risk factor development plays a crucial role. A holistic approach to modify the prevalent lifestyle conditions, especially in urban areas is the need of the hour. School based interventions incorporating behaviour change communication should be used to reduce the modifiable risk factors and promote healthy lifestyle. Yoga and meditation can be incorporated in the school curriculum to tackle high stress.

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