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ORIGINAL RESEARCH

Prevalence and determinants of hypertension in adolescents (15 to 19 years of age) – A school based analytical cross-sectional study

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Abstract

Background: The primary objective of the study was to estimate the prevalence of hypertension among school going adolescents (15 to 19 years) and to identify factors associated with hypertension among the study participants.

Methods: An analytical cross-sectional study was carried out between July 2019 and December 2019 in a senior secondary school, located in Mandir Hasaud, Arang Tehsil of Raipur district in Chhattisgarh, India; including adolescents15 to 19 years of age using simple random sampling. Data was collected using Google forms and analyzed with Stata v16.

Results: The prevalence of hypertension among school going adolescents aged 15 to 19 years was 2.5%. Also, 12.0% adolescents were prehypertensive. The significant predictors of hypertension among adolescents were presence of family history of hypertension (Adjusted odds ratio (AOR) 3.1, 95% CI 1.2 to 12.7), physical inactivity (AOR 21.4, 95% CI (2.6 to 50.8), presence of smoking (AOR 11.9, 95% CI 1.6 to 36.3) and alcohol consumption (AOR 4.8, 95% CI 2.1 to 14.7).

Conclusion: It is the need of the hour to mobilize preventive and promotive efforts focused on individual, family, and community for the health of the futuregeneration.

Keywords: hypertension, adolescents, obesity, smoking, alcohol, physical activity

Introduction

Hypertension is a public health problem of global proportions.(1)Raised blood pressure affects morethan 1 billion people worldwide; and it is ever increasing.(2)Hypertension contributed to 12.8% (7.5 million) of the total of all deaths globally.(3)Overall, it contributed 9.2% (95% CI, 8.3 to 10.2%) of disability adjusted life years (DALYs) for men and 7.8% (95%CI, 6.9 to 8.7%) of DALYsfor women in 2015.(4)Untreated or uncontrolled, hypertension is thesingle largest contributor tocardiovascular disease, causing stroke (attributable risk of 54%), heart failure,coronary artery disease (attributable risk of 47%) and kidneydisease (attributable risk of 50% to 80%).(5, 6)

Age is by far the most important risk factor; with the proportion of cases and risk of being hypertensive increasing with each progressive age group.(7, 8) However, with globalization bringing more lifestyle changes, adolescents are now exposed to multiple risk factors that

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predispose them to acquire non-communicable diseases, hypertension in particular. The global prevalence of hypertension in children 19 years and younger was 4.0% (95% CI, 3.3 to 4.8%) in 2019.(9)Habits formed during adolescence could prevent or aid and accelerate the early development of many chronic diseasesincluding obesity and hypertension. For instance, health-related behaviors that usually start in adolescence (tobacco and alcohol use, obesity, and physical inactivity) contribute to high blood pressure, elevated cholesterol, and glucose in older adults accounting for 29% of disability-adjusted life-years (DALYs).(10) Such diseases can affect productivity and quality of life, contributing to high health-care costs.(11) Planning prevention measures to improve health status of adolescents could be effective interventions to tackle the rising burden of lifestyle diseases.(12)

The India State-Level Disease Burden Initiative in 2017 by Indian Council of Medical Research (ICMR) estimated the proportion of deaths due to non-communicable diseases (NCDs) in India have increased from 37.9% in 1990 to 61.8% in 2016.(13) Cardiovascular diseases alone contribute a DALY of 6.6%– a 3.7% increase in comparison to 1990.(13)With increasing prevalence and early occurrence, hypertension is now a concern not limited to adults, but in children and adolescents as well.Hypertension in young is real; pathophysiological and epidemiological evidence suggests that essential hypertension and the precursors of cardiovascular diseases originate in childhood but go undetected unless specifically looked for during this age group.(14-16)Childhood blood pressure is a strong indicator of adult blood pressure.(17) This highlights the importance of blood pressure tracking, early identification, and management. A meta-analysis published in 2020 found that the prevalence of hypertension among adolescents (10–19 years) in India was 7.6% (95% CI, 6.1 to 9.1%), ranging between 2% and 20.5%.(18)

Against this background, the aim of the study was to detect hypertension among adolescents early, so that they can be appropriately managed nullifying therisk of complications. The primary objective of the study was to estimate the prevalence of hypertension among school going adolescents (15 to 19 years) and to identify factors associated with hypertension among the study participants.

Methods

An analytical cross-sectional study was carried out between July 2019 and December 2019 in a senior secondary school, located in Mandir Hasaud, Arang Tehsil of Raipur district in Chhattisgarh, India. All adolescents (aged 15 to 19 years)present on the day of survey constituted the sampling frame.

Previous literature showed the prevalence of hypertension among adolescents to range between 2% and 20.5%.(18) We computed sample size using 20.5% prevalence (to obtain maximum sample size), 10.0% absolute precision and 95% confidence interval (CI). As the study participants were selected from only one school and not from all schools in Raipur, Chhattisgarh – to account for the variation in probability at which participants are selected, we used design effect of two. Finally, the minimum sample size was estimated to be 140. A simple random sampling was done to include a sample of 200adolescents. The school was visited twice; on day 1, permission was sought from school principal, explanation of the study was given, and consent/assent forms were handed out to all eligible students. On day 2 the predesigned, pretested, semi-structured proforma that includedsociodemographic factors and risk factor assessment for hypertension was administered. This was followed by structured measurement of blood pressure. Following health assessment, the study participants were organized in groups and were then given health education (based on predesigned module) in the Hindi language through an interactive talk. Health education was focused primarily on risk of hypertension and other non-communicable diseases; ways to prevent and control the same.

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The primary outcome, blood pressure was obtained when the participants were relax, sitting in a chair (feet on floor, back supported) for more than five minutes. It was ensured that the participant did not consume caffeine or did exercise or smoking for at least 30 min before measurement. It was also ensured that the participant emptied his/her bladder. Two readings were obtained from each participant separated by at least two minutes and an average was taken to document the final measurement. This was then categorised in accordance with Eighth Joint National Committee (JNC 8) and reported [Normal, < 120/80 mmHg; Prehypertensive, 120-139/80-89 mmHg; Stage 1 HTN, 140-159/90-99 mmHg; Stage 2 HTN > 160/> 100 mmHg].(19, 20)Measurement of weight (to the accuracy of 100 gm) and height (0.1 mm) was done using standardized, calibrated weighing machine and stadiometerrespectively. Body mass index (BMI) computed using Quetelet's index (kg/m^2) was categorized based on cut-points for BMI categories in Asian populations as follows: less than 18.5, 18.5 to 23, 23 to 27.5, and more than or equal to 27.5 for underweight, normal weight, overweight and obese respectively.(21, 22) We considered recreational drugs as those synthetic or naturally available, and taken for its psychoactive nature, with users thinking that their sporadic consumption cannot be addictive.

Data collected using Google forms were downloaded in Excel format and analysed using Stata v16. The data was described using numbers, percentages and presented in tables. Chi square test of significance (two-sided) was applied to test for association between hypertension or prehypertension and independent variables. Univariate odds ratio was estimated along with 95% CI for these variables. All predictor variables significant at $p<0.05$ in univariate analysis were included in multivariate logistic regression analysis. Adjusted odds ratios (95% CI) were presented. We used directed acyclic graph (DAG) to identify that set of factors to be adjusted for to compute the total effect of predictors on hypertension in adolescents.(23)The study was approved by Institute Ethical Committee (IEC),Raipur Institute of Medical Sciences (RIMS), Raipur. The approval was also obtained from the head of department, school principal and teachers. Consent or assent from parents and students were obtained a prior.

Results

The study included 200 adolescents aged 15 to 19 years (Mean 17.6, SD 1.2) of which 52.0% were males. In terms of parents educaiton, mojority of the fathers had a middle school certificate (32.0%), whereas mojority of mothers had a primary school certificate (35.5%). In terms of parents occupation, majority of fathers were skilled workers (55.5%) and mojority of mothers were unskilled workers (47.5%) (Table 1).

Table 1: Sociodemographic characteristics of the study population

Variables		**n (%) or mean (SD)**
Age in years, mean (SD)		17.6 (1.2)
Gender	Male	104 (52.0)
	Female	96 (48.0)
Father's education	Profession or Honours	0 (0.0)
	Graduate or Postgraduate	2 (1.0)
	Intermediate or Post high school diploma	5 (2.5)
	High school certificate	25 (12.5)
	Middle school certificate	64 (32.0)
	Primary school certificate	57 (28.5)
	Illiterate	26 (13.0)
Mother's education	Profession or Honours	0 (0.0)
	Graduate or Postgraduate	2 (1.0)

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	Intermediate or Post high school diploma	4 (2.0)
	High school certificate	24 (12.0)
	Middle school certificate	41 (20.5)
	Primary school certificate	71 (35.5)
	Illiterate	38 (19.0)
Father's occupation	Professional (White collar)	3 (1.5)
	Semi-professional	4 (2.0)
	Clerical, shop owner/ farm	7 (3.5)
	Skilled worker	111 (55.5)
	Semi-skilled worker	0 (0.0)
	Unskilled worker	68 (34.0)
	Unemployed	7 (3.5)
Mother's occupation	Professional (White collar)	1 (0.5)
	Semi-professional	1 (0.5)
	Clerical, shop owner/ farm	4 (2.0)
	Skilled worker	30 (15.0)
	Semi-skilled worker	0 (0.0)
	Unskilled worker	95 (47.5)
	Unemployed	69 (34.5)
***Father's education not known for 21 (10.5%) participants #Mother's education not known for 20 (10.0%) participants**		

Prevalence of hypertension

The prevalence of hypertension among school going adolescents aged 15 to 19 years was 2.5% (all stage I hypertension; none were of stage II hypertension). The results also showed that 12.0% of adolescents aged 15 to 19 years were prehypertensive (Table 2).

Table 2: Distribution of blood pressure in accordance with JNC-8 criteria

Blood pressure category	**Pre intervention N = 200**
	n (%)
Normal	171 (85.5)
Prehypertensive	24 (12.0)
Stage 1 HTN	5 (2.5)
Stage 2 HTN	0 (0.0)
Blood pressure was categorized as Normal, < 120/80 mmHg; Prehypertensive, 120-139/80-89 mmHg; Stage 1 HTN, 140-159/90-99 mmHg; Stage 2 HTN $\geq$ 160/$\geq$ 100 mmHg HTN, Hypertension	

Predictors of hypertension

Univariate analysis showed that the gender was not significantly associated with hypertension in adolescents (OR 0.6, 95% CI 0.3 to 1.3). However, the results showed that presence of family history of hypertension, obesity, physical inactivity, smoking, alcohol consumption, pre-existing diseases, and use of recreational drugs were significantly associated with hypertension in adolescents ($p < 0.05$). All these factors, except gender, were then subjected to multivariate logistic regression analysis (Tables 3 and 4).

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Table 3: Distribution of risk factors by presence or absence of prehypertension and hypertension

Variables		Prehypertension and Hypertension present (N = 29)	Prehypertension and Hypertension absent (N = 171)	Total (N = 200)
		n (%)	n (%)	n (%)
Gender	Male	12 (41.4)	92 (53.8)	104 (52.0)
	Female	17 (58.6)	79 (46.2)	96 (48.0)
Family history of HTN	Present	20 (69.0)	42 (21.0)	62 (31.0)
	Absent	9 (31.0)	129 (64.5)	138 (69.0)
Obesity	Present	24 (82.8)	31 (18.1)	55 (27.5)
	Absent	5 (17.2)	140 (81.9)	145 (72.5)
Physical activity	Absent	25 (86.2)	20 (11.7)	45 (22.5)
	Present	4 (13.8)	151 (88.3)	155 (77.5)
Smoking	Present	22 (75.9)	18 (10.5)	40 (20.0)
	Absent	7 (24.1)	153 (89.5)	160 (80.0)
Alcohol consumption	Present	10 (34.5)	9 (5.3)	19 (9.5)
	Absent	19 (65.5)	162 (94.7)	181 (90.5)
Pre-existing disease	Present	11 (37.9)	4 (2.3)	15 (7.5)
	Absent	18 (62.1)	167 (97.7)	185 (92.5)
Recreational drug use	Present	4 (13.8)	6 (3.5)	10 (2.5)
	Absent	25 (86.2)	165 (96.5)	190 (95.0)

Table 4: Univariate and multivariate regression analysis

Variables		Odds ratio (95% CI)	p value	Adjusted odds ratio (95% CI)	p value
Gender	Male	0.6 (0.3 to 1.3)	0.219	_	_
	Female	1			
Family history of HTN	Present	6.8 (2.9 to 16.1)	<0.001	3.1 (1.2 to 12.7)	0.021
	Absent	1		1	
Obesity	Present	21.7 (7.7 to 61.3)	<0.001	8.5 (0.3 to 29.1)	0.174
	Absent	1		1	
Physical activity	Absent	47.2 (14.9 to 149.6)	<0.001	21.4 (2.6 to 50.8)	0.036
	Present	1		1	
Smoking	Present	26.7 (10.0 to 71.2)	<0.001	11.9 (1.6 to 36.3)	0.042
	Absent	1		1	
Alcohol consumption	Present	9.5 (3.4 to 26.2)	<0.001	4.8 (2.1 to 14.7)	0.030
	Absent	1		1	
Pre-existing disease	Present	25.5 (7.4 to 88.5)	<0.001	9.3 (0.3 to 28.5)	0.272
	Absent	1		1	
Recreational drug	Present	4.4	0.029	2.7	0.538

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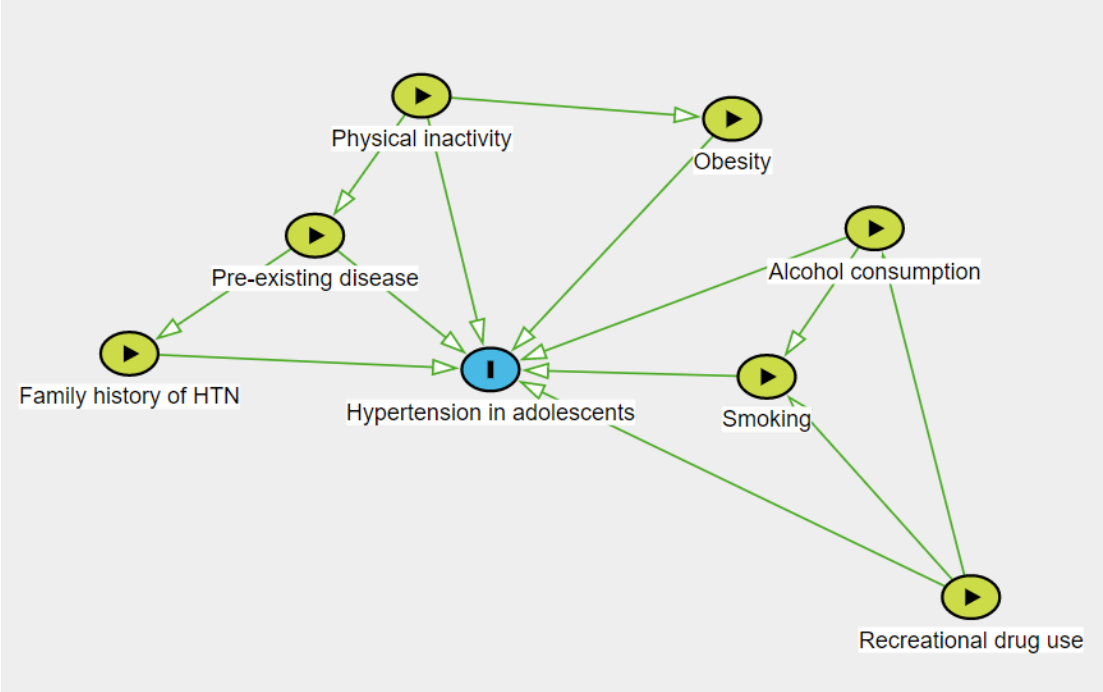
use		(1.2 to 16.7)		(0.2 to 5.8)	
	Absent	1		1	
*Significance was taken at p <0.05 95% CI, 95% confidence interval					

The study found that the presence of family history of hypertension (Adjusted odds ratio (AOR) 3.1, 95% CI 1.2 to 12.7), physical inactivity (AOR 21.4, 95% CI (2.6 to 50.8), presence of smoking (AOR 11.9, 95% CI 1.6 to 36.3) and alcohol consumption (AOR 4.8, 95% CI 2.1 to 14.7) were statistically significant predictors of hypertension of adolescents (15 to 19 years of age). Directed acyclic graphs showed that no adjustment is necessary to estimate the total effect of family history of hypertension, obesity, smoking, alcohol consumption, pre-existing disease, recreational drug use, and physical inactivity on hypertension in adolescents (Figure 1).

Figure 1: Directed acyclic graph with hypertension in adolescents as outcome



Discussion

The study found the prevalence of hypertension among adolescents aged 15 to 19 years to be 2.5%. Also, 12.0% of adolescents were prehypertensive. The significant predictors of hypertension among adolescents were presence of family history of hypertension, physical inactivity, presence of smoking and alcohol consumption.

The findings of this study corroborate with the findings of a meta-analysis that reported the global prevalence of hypertension and prehypertension in those 19 years and younger.(9) Similar findings were documented by a recently published systematic and meta-analysis that reported the pooled prevalence of hypertension among adolescents 10 to 19 years of age in India.(18)The prevalence of hypertension among adolescents from African region were slightly higher; the prevalence of systolic or diastolic pressure more than or equal to 95th percentile (elevated blood pressure) was 5.5% (95% CI 4.2 to 6.9), whereas that of systolic or diastolic blood pressure more than or equal to 90thpercentile (slightly elevated) was 12.7% (95% CI 2.1 to 30.4).(4) These results must be interpreted with the understanding that prevalence of hypertension among adolescents was higher in school-based studies in comparison with community-based studies.(24)Though the prevalence ranges only between 2.0% to 6.0%, hypertension in adolescents is a major public health threat for two important

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reasons. Firstly, the absolute number of adolescents available. Adolescents constitute 16% of world's population.More than half of alladolescents live in Asia, especially South Asia.(25) Of the 350 millionadolescents from South Asia, about 243 million are from India, 21% of the Indian population.(25) Secondly, the chronic and progressive nature of illness, associated economic costs and quality of life. Evidence shows that among adolescents with documented single measurement of blood pressure in pre-hypertensive range, hypertension (either stage I or II) was confirmed in 14.0% of boys and 12.0% of girls within next two years.(26, 27) The rate of progression from prehypertension to hypertension is around 7.0% annually.(28)

This present study showed that the predictors of hypertension did not vary for adolescents in comparison with predictors of hypertension in adulthood. Obesity leading to metabolic disturbances like hyperinsulinemia, hypertriglyceridemia,high cholesterol, increased cortisol, and increased freefatty acids is an important risk factor of hypertension.(29)However, in contrary to the findings of this study, the risk of hypertension was higher among obese adolescents; reported prevalence ofhypertension was 6.8% and 61.8% in overweight andobese respectively.(30)This association was found in both boys and girls.(31)Family history of hypertension in addition to family characteristics are important factors that predispose an individual to either overweight or obesity, and in due course hypertension.(32) Similar to the findings of this study, association between parental blood pressure and hypertension in adolescents has been reported earlier.(33)This may be due to geneticinfluence and the shared behaviours such as physical activities, diet and salt intake which are risk factors of hypertension.

The study has a few limitations. The study failed to bring out the difference in risk of hypertension among early and late adolescents, urban and rural adolescents. Being a school-based study, information on family income (essential to compute socioeconomic status), near accurate daily salt intake and blood investigations could not be performed. The temporality of the predictors of hypertension could not be established (inherent limitation of study design).

A holistic approach aimed at modifying the prevalent lifestyle changes, especially in urban areas is the need of the hour. Universal screening of children and adolescents for blood pressure and its predictive factors, both environmental and genetic should be implemented. This should not be an one-time activity; blood pressure should be tracked from childhood through adolescence into adulthood. Organizational support of school health program should be utilized. Opportunistic screening of children and adolescents at outpatient departments (paediatric or non-paediatric) is also a potential option. Schools must be equipped with appropriate resources to formulate context specific policies for addressing junk foods consumed in the school premises as well as outside; for promotion of sports and recreational activities; promotion of yoga and meditation; and for tobacco frees premises. The primary aim of these policies will be to achieve healthy behavioural change and health promotion. Restrictions on advertising, promotion, and availability of tobacco products, alcohol and junk foods to children and adolescents should beconstituted, not just near schools but across communities.

Conclusion

The prevalence of hypertension among adolescents was 2.5%. Also, 12.0% of adolescents were prehypertensive. It is the need of the hour to mobilize preventive and promotive efforts focused on individual, family,and community for the health of the futuregeneration.

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Compliance With Ethical Standards.

Conflict Of Interest
None**.**

Funding
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Consent
Obtained**.**

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