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Original Research Article

Prevalence and related factors for pre-hypertension and hypertension amongst school going adolescents in a rural area of central India: a cross-sectional study

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ABSTRACT

Background: Adolescence is a critical period of rapid growth and development, marked by significant physical and metabolic changes. During this stage, many risk factors for adult diseases begin to emerge. In India, both undernutrition and increasing rates of overweight and obesity among adolescents have become important public health concerns. Rising obesity levels are associated with an increased prevalence of high blood pressure in this age group, which may persist into adulthood and contribute to cardiovascular diseases. Early identification through regular monitoring of blood pressure, height, and weight, along with promotion of healthy lifestyle practices, is essential to prevent these long-term health problems.
Methods: A cross-sectional study was conducted among adolescents studying in randomly selected government schools in a rural area of central India. Age was determined using birth dates recorded in school registration records. Information from each student was collected using a pretested questionnaire. All eligible adolescents were included in the study through universal sampling.
Results: Adolescents aged 15-16 years constituted the majority of participants, with females slightly predominating. The prevalence of pre-hypertension and hypertension was 15.92% and 9.95%, respectively. Higher BMI, frequent consumption of junk or salty foods, physical inactivity, and a family history of hypertension showed a statistically significant association with elevated blood pressure.
Conclusions: A considerable proportion of rural adolescents had pre-hypertension or hypertension. Elevated blood pressure was significantly associated with modifiable lifestyle factors and nutritional status. Early screening, health education, and school-based interventions promoting healthy diet, regular physical activity, and weight management are essential to prevent future cardiovascular morbidity.

Keywords: Adolescents, Blood pressure, BMI, Hypertension, Obesity

INTRODUCTION

Adolescence represents a formative stage of life characterized by rapid biological, emotional, and social changes, during which foundations for adult health are established. The World Health Organization has highlighted that adolescents have distinct health needs and that many chronic non-communicable diseases originate from risk factors acquired during this period. Elevated blood pressure in adolescence is one such condition that often goes unnoticed but has important long-term health implications.[1]

Hypertension is recognized globally as a major public health challenge and is often termed a “silent killer” due to its asymptomatic progression and association with serious cardiovascular complications. While hypertension has traditionally been viewed as an adult condition, growing evidence indicates that pre-hypertension and hypertension frequently begin in childhood and

adolescence. Blood pressure levels in early life tend to persist into adulthood, thereby increasing the likelihood of future cardiovascular disease, making early detection and prevention crucial.[2]

Global and regional studies have reported an increasing trend in blood pressure levels among children and adolescents. This rise has been attributed to changing lifestyle patterns, including unhealthy dietary practices, reduced physical activity, increasing prevalence of overweight and obesity, psychological stress, and sedentary behaviors. Longitudinal observations suggest a gradual shift towards higher blood pressure values in adolescent populations, emphasizing the need for regular screening and early intervention.[3]

Recent research from India and other countries has demonstrated a substantial prevalence of pre-hypertension and hypertension among adolescents in both rural and urban settings. These studies have identified several associated factors such as age, gender, nutritional status, body mass index, physical inactivity, dietary habits, and family history of hypertension. Similar patterns have been observed in studies conducted in other low- and middle-income countries, indicating that elevated blood pressure among adolescents is a widespread and emerging public health concern.[4-15]

However, there is a relative scarcity of data focusing specifically on school-going adolescents from rural areas of central India. Adolescents residing in rural settings may experience a unique mix of traditional lifestyles and emerging behavioral risk factors, necessitating region-specific evidence. Generating local data is essential for designing effective preventive and promotive health strategies. Hence, the present study was undertaken to estimate the prevalence of pre-hypertension and hypertension among rural school-going adolescents and to assess selected factors associated with elevated blood pressure in this population.[13]

METHODS

A school-based cross-sectional study was conducted from August to October 2025 in a rural area of central India. One government school was selected randomly from a total of eight government schools in the study area.

The study population comprised school-going adolescents aged 10-19 years enrolled in the selected government school. Universal sampling was adopted, and all eligible adolescents present during the study period were included. A total of 403 adolescents participated in the study. All adolescents aged 10-19 years who were enrolled in the selected school and whose parents/guardians provided written informed consent were included in the study. Adolescents with known chronic diseases and those whose parents did not give consent were excluded.

Data were collected using a predesigned and pretested structured proforma. Information regarding age, sex, class of study, dietary habits (with special emphasis on junk and salty food consumption), duration of physical activity, and family history of hypertension was obtained. Age was confirmed from the date of birth recorded in school registration records.

Anthropometric measurements including height and weight were recorded following standard procedures. Height was measured using a stadiometer to the nearest 0.1 cm with the participant standing erect without footwear. Weight was measured using a calibrated digital weighing scale to the nearest 0.1 kg with minimal clothing. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). BMI was categorized according to the Indian Academy of Pediatrics (IAP) revised growth charts, classifying adolescents into underweight, normal, overweight, and obese categories.

Blood pressure was measured using a standardized, calibrated digital sphygmomanometer with appropriate cuff size. Measurements were taken in the sitting position after the participant had rested for at least five minutes. Two readings were recorded at an interval of five minutes, and the average of the two readings was considered for analysis. Blood pressure was classified as normal, elevated blood pressure (pre-hypertension), or hypertension according to the American Heart Association (AHA) guidelines.

Physical activity was assessed based on the self-reported duration of daily physical activity. Adolescents were categorized into adequate and inadequate physical activity groups based on recommended physical activity guidelines.

Data were entered into Microsoft Excel and analyzed using Jamovi software. Qualitative variables were expressed as frequencies and percentages, while quantitative variables were summarized using mean and standard deviation. The association between categorical variables was tested using the Chi-square test. A p value of less than 0.05 was considered statistically significant.

Approval for the study was obtained from the institutional ethics committee prior to commencement of the study. Permission was also taken from the school authorities. Written informed consent was obtained from parents or guardians, and assent was taken from the adolescents before data collection. Confidentiality and anonymity of the participants were maintained throughout the study.

RESULTS

A total of 403 school-going adolescents participated in the study. As shown in Figure 1, females constituted a slightly higher proportion of the study population (53%) compared to males (47%). The age distribution of

participants is depicted in Figure 2, with the majority belonging to 16 years of age (n=80), followed by 15 years (n=59). The study included adolescents aged 10-18 years.

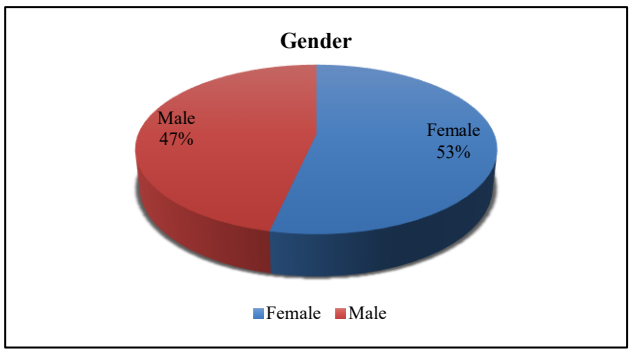

Figure 1: Distribution of students according to gender.

Based on blood pressure assessment, 299 (74.19%) adolescents were normotensive, 64 (15.92%) had elevated blood pressure, and 40 (9.95%) were found to be hypertensive.

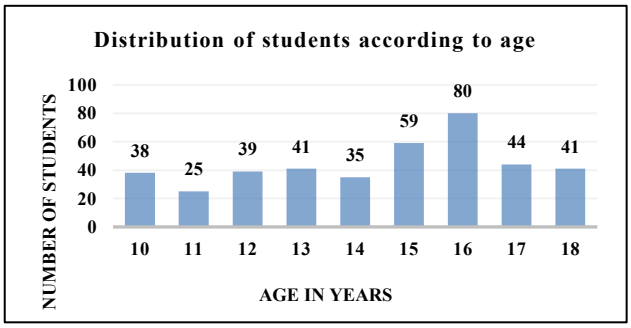

Figure 2: Distribution of students according to age.

Table 1: Prevalence of elevated BP and hypertension by BMI.

BMI Status	Number (n=403)	Normal BP (%)	Elevated BP (%)	Hypertension (%)	P value
Underweight	55 (13.68)	45 (81.80)	6 (10.39)	4 (7.81)	0.0449 (p<0.05, df=4)
Normal	303 (75.12)	224 (74.32)	52 (17.22)	26 (8.46)	
Overweight/obese	45 (11.20)	30 (65.66)	6 (13.13)	10 (21.21)	

Table 2: Association of selected risk factors with blood pressure status among adolescents.

Risk Factor	Category	Normal BP (n=299) (%)	Pre-hypertension (n=64) (%)	Hypertension (n=40) (%)	P value
Junk/salty food frequency/week	0-2 times	144 (48.16)	31 (48.44)	9 (22.50)	0.0005
	2-3 times	123 (41.14)	27 (42.19)	17 (42.50)	
	4-5 times	18 (6.02)	4 (6.25)	10 (25.00)	
	≥6 times	14 (4.68)	2 (3.13)	4 (10.00)	
Physical activity	Adequate	266 (88.96)	56 (87.50)	23 (57.50)	<0.0001
	Inadequate	33 (11.04)	8 (12.50)	17 (42.50)	
Family history of hypertension	Yes	55 (18.39)	18 (28.13)	15 (37.50)	0.0095
	No	244 (81.61)	46 (71.88)	25 (62.50)	

Table 1 depicts the distribution of blood pressure status according to BMI categories. Among the participants, 55 (13.68%) were underweight, 303 (75.12%) had normal BMI, and 45 (11.20%) were classified as overweight or obese. The prevalence of hypertension was highest among overweight/obese adolescents (21.21%), followed by those with normal BMI (8.46%) and underweight adolescents (7.81%). Elevated blood pressure was observed in 13.13% of overweight/obese adolescents compared to 17.22% in the normal BMI group and 10.39% among underweight adolescents. The association between BMI status and blood pressure category was statistically significant (χ^2=9.80, df=4, p=0.0449).

The association between selected risk factors and blood pressure status is presented in Table 2. A statistically significant association was observed between the frequency of junk/salty food consumption and blood pressure status (p=0.0005). Adolescents consuming junk/salty food 4-5 times per week and ≥6 times per week showed a higher proportion of hypertension compared to those consuming such foods 0-2 times per week.

Physical activity was strongly associated with blood pressure status (p < 0.0001). Among adolescents with adequate physical activity, 88.96% were normotensive, whereas 42.50% of those with inadequate physical activity were hypertensive.

Family history of hypertension was also significantly associated with elevated blood pressure (p=0.0095). A positive family history was reported by 37.50% of hypertensive adolescents and 28.13% of those with elevated blood pressure, compared to 18.39% among normotensive participants.

DISCUSSION

The present cross-sectional study assessed the prevalence of pre-hypertension and hypertension among school-going adolescents in a rural area of central India and examined selected associated factors. Adolescence is a vulnerable period during which early physiological changes and lifestyle behaviors can significantly influence long-term cardiovascular health. The World Health Organization has long emphasized the importance of addressing adolescent health needs to prevent the future burden of non-communicable diseases.[1]

In the present study, a higher proportion of students were females compared to males, with most participants belonging to the mid-adolescent age group. Similar age distributions have been reported in community- and school-based studies conducted in rural and urban India, where adolescents aged 13-16 years constituted the majority of study participants. This age group is particularly susceptible to developing elevated blood pressure due to rapid growth, hormonal changes, and evolving lifestyle patterns.[4,5]

The prevalence of elevated blood pressure and hypertension was found to be significantly associated with body mass index. Adolescents who were overweight or obese showed a higher proportion of hypertension compared to those with normal or underweight BMI. This finding is consistent with studies conducted in rural North India and multicentric Indian studies, which reported a strong positive association between increased BMI and elevated blood pressure among adolescents. Excess adiposity contributes to insulin resistance, sympathetic overactivity, and vascular changes, thereby increasing blood pressure levels.[4,5,7]

A statistically significant association was observed between the frequency of junk or salty food consumption and blood pressure status. Adolescents consuming junk food more frequently showed a higher prevalence of pre-hypertension and hypertension. Similar associations have been documented in Indian and international studies, where high salt intake and consumption of energy-dense processed foods were identified as important contributors to elevated blood pressure in adolescents. These dietary patterns are increasingly prevalent even in rural areas due to changing food environments and preferences.[6,7]

Physical activity emerged as a strong protective factor in the present study, with inadequate physical activity showing a significant association with hypertension. Adolescents who reported inadequate physical activity had a markedly higher prevalence of hypertension compared to those who were physically active. Comparable findings have been reported from rural North India, Indonesia, and large national Indian studies, emphasizing that sedentary behavior and reduced physical activity play a critical role in the development of elevated blood pressure during adolescence.[4,6,7]

Family history of hypertension was also significantly associated with elevated blood pressure among adolescents in this study. Adolescents with a positive family history had higher proportions of pre-hypertension and hypertension compared to those without such history. This observation aligns with findings from multiple studies conducted in India and other countries, highlighting the role of genetic predisposition combined with shared environmental and lifestyle factors in the development of adolescent hypertension.[4,6]

The findings of the present study reinforce the growing evidence that pre-hypertension and hypertension are no longer uncommon among adolescents, even in rural settings. The World Health Organization has recognized hypertension as a global public health crisis, and early identification during adolescence is essential to prevent its progression into adulthood. Monitoring blood pressure and addressing modifiable risk factors such as unhealthy diet, physical inactivity, and excess body weight during adolescence can substantially reduce the future burden of cardiovascular disease.[2,3]

This study has certain limitations. The cross-sectional design of the study limits the ability to establish a causal relationship between elevated blood pressure and the associated risk factors identified. Blood pressure measurements were recorded during a single visit, which may have led to misclassification due to temporary variations or white-coat effect.

Dietary habits and physical activity levels were assessed using self-reported information, making the findings susceptible to recall and reporting bias.

CONCLUSION

The present study demonstrated a considerable prevalence of pre-hypertension and hypertension among school-going adolescents in a rural area of central India. Elevated blood pressure was significantly associated with higher BMI, frequent consumption of junk and salty foods, inadequate physical activity, and a positive family history of hypertension. Overweight and obese adolescents exhibited a markedly higher proportion of hypertension compared to those with normal or low BMI.

These findings highlight adolescence as a critical period for early detection of elevated blood pressure and underscore the need for school-based screening, lifestyle modification, and health promotion interventions focusing on healthy dietary practices, regular physical activity, and weight management to prevent future cardiovascular disease burden.

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