ORIGINAL ARTICLE

Prevalence and Determinants of Raised Blood Pressure among Adolescents and Youth (10-24 Years): A Cross-Sectional Study in Rural Varanasi

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ABSTRACT

Background: Raised blood pressure (Elevated BP and Hypertension) in adolescence is an emerging public health concern, but evidence on it's burden and determinants among rural adolescents and youth in India remains limited. **Objective**: To determine the prevalence of Raised blood pressure and identify its determinants among adolescents and youth aged 10-24 years in rural areas of Varanasi district, Uttar Pradesh. **Methods**: A community-based cross-sectional study was conducted among 270 school and college-going participants. Blood pressure was measured using a standardized digital sphygmomanometer and classified using the 2017 American Academy of Pediatrics guideline (10-17 years) and ACC/AHA 2017 criteria (≥18 years). Socio-demographic, anthropometric, and lifestyle factors were assessed using a pre-tested questionnaire. Associations were analyzed using Chi-square/Fisher's Exact tests and multivariable logistic regression. **Results**: Overall, 127 (47.0%) participants had raised blood pressure, including 114 (42.5%) having Elevated BP and 13 (4.9%) having Hypertension. Prevalence was highest in the 15-19 year age group. Late adolescence was strongly associated with elevated blood pressure (aOR 4.77; 95% CI: 2.06-11.04), and males had higher odds than females (aOR 2.43; 95% CI: 1.07-5.49). Underweight status was protective (aOR 0.31; 95% CI: 0.16-0.61). **Conclusion**: The burden of Raised BP was high. Late adolescence and male sex were key determinants, emphasizing the need for early screening and prevention in rural adolescent health programs.

KEYWORDS

Hypertension, Adolecsents, Rural

INTRODUCTION

Hypertension is a major known modifiable risk factor for cardiovascular diseases. There is growing evidence that Raised Blood Pressure (Elevated BP and Hypertension) is being increasingly detected among younger age groups.(1) This has shown to track into adulthood, making it an important predictor of cardiovascular risk.(2) With India undergoing the period of epidemiological transition, there has been a significant shift in the burden of Non Communicable Diseases (NCDs). The National Family Health Survey (NFHS-5) documents rising prevalence of hypertension, along-with overweight and obesity, among individuals aged 15-19 and 15-24 years of age.(3) Many community based studies and systematic reviews from India, have highlighted a considerable proportion of adolescents having elevated blood pressure.(4)The Government of India acknowledges the growing importance of NCD prevention among adolescents, and initiatives such as the Rashtriya Kishor Swasthya Karyakram (RKSK), address NCDs as separate focus area.(5)Evidence of the prevalence and determinants of Raised Blood Pressure, among rural adolescents and youth, remains limited.(6)

Aim & Objective(s)

- To determine the prevalence of Raised Blood Pressure among adolescents and youth aged 10-24 years in rural areas of Varanasi
- To identify the determinants of Raised Blood Pressure among adolescents and youth aged 10-24 years in rural areas of Varanasi

MATERIAL & METHODS

Study Type and Study Design- Analytical Cross Sectional Study

Study Setting- Schools and Colleges in Cholapur and Chiraigaon Blocks of Varanasi district.

Study Population- School and college-going adolescents and youth (10-24 years)

Study Duration- February 2025- August 2025

Sample Size-

Using the below formula for sample size calculation:

$$n = \frac{z^2 \times p(1-p)}{d^2}$$

Where, Prevalence(P)11 =0.35
Z= 1.96
(1-p) = 0.65
d- 0.06
The sample size comes out to be 243,
Giving allowance to non-response of 10%,
n = 268 (Rounded off to 270)

Inclusion Criteria- 1. Students aged 10-24 years studying in the selected schools or colleges.
2. Students who gave written informed assent/consent (and parental consent for <18 years).

Exclusion Criteria- 1. Individuals with known chronic illnesses or medication.
2. Students who declined to participate or were absent.

Strategy for Data Collection- A multistage stratified random sampling technique was employed.

Stage 1: Two rural blocks (Cholapur and Chiraigaon) among the eight development blocks in Varanasi, were randomly selected from the total rural blocks in Varanasi district using a lottery method, which helped capture variations in Socio Demographic characteristics, Health seeking behaviour, and access to healthcare services, while maintaining logistical feasibility and resource efficiency.

Stage 2: Within each block, a list of all schools and colleges was obtained. Institutions were selected randomly using simple random sampling.

Stage 3: Stratification was done based on age group into, 10-14 years and 15-24 years. From each selected school or college, class-wise lists of eligible students were obtained. Participants were randomly selected from the lists within each age stratum to meet the required sample size. The sample was proportionally allocated to each age group based on expected distribution in the population.

Blood Pressure Measurement: Blood pressure was measured using a standardized digital sphygmomanometer (OMRON Digital BP Monitor, Kyoto Japan: OMRON Healthcare) after ensuring proper calibration. Participants were asked to sit calmly for at least 5 minutes prior to the measurement. Measurements were taken on the right arm at heart level using an appropriately sized cuff. Two readings were recorded at a 5-minute interval; the average was used for analysis.

Assessment of Dietary and Lifestyle Factors: Dietary habits and lifestyle-related determinants were assessed using a pre-tested semi-structured questionnaire administered to all participants. The frequency of consumption of outside drinks, including sugar-sweetened beverages and packaged drinks, was categorized based on self-reported weekly intake as daily (≥7 times/week), frequent (3-6 times/week), occasional (1-2 times/week), and rare (<1 time/week or only during special occasions). Similarly, intake of outside food (fast food/junk food items) was classified as high (≥3 times/week), moderate (1-2 times/week), and low (<1 time/week). Fruit and vegetable consumption was recorded as the number of days per week and grouped into daily (7 days/week), 4-6 days/week, and 2-3 days/week. Physical activity status was assessed based on engagement in exercise or outdoor sports and categorized as daily (performed every day), sometimes (1-6 days/week), or never (no regular physical activity). Tobacco use was assessed as per standard adolescent surveillance definitions, and participants reporting use of any tobacco product within the past 30 days were considered tobacco users.

Working Definition- For the study, Raised Blood pressure was defined based on Blood Pressure Categorization according to the 2017 AAP guideline for participants aged 10-17 years and adult ACC/AHA 2017 criteria for participants aged ≥18 years, and included both Elevated Blood pressure and Hypertension grade 1 and 2.

Ethical Clearance and Informed Consent: Ethical clearance was obtained from the institutional ethics committee at IMS BHU (IMS/IEC/2025/7861). Data was collected after taking Verbal Assent and parental consent for participants 10-12 years, written assent and parental consent for 12-17 years and informed consent for participants 18 years and above.

Data Analysis: The collected data was entered into Microsoft Excel and analysed using SPSS version 27. The characteristics of the participants were described in terms of percentages and 95% confidence intervals for categorical variables. Unadjusted and adjusted odds ratios were computed by bivariable and multivariable logistic regression, respectively, for the association between dependent and independent variables. A p-value of less than 0.05 was taken to be significant.

RESULTS

Among the study participants, 127 (47.0%) had Raised blood pressure (Elevated BP or hypertension). A high proportion of participants (42.5%) had Elevated BP. The prevalence of Hypertension (4.9%) was lower but not negligible.

Raised Blood Pressure was maximum in the 15-19 year age group, with nearly two-thirds showing Elevated BP or Hypertension. Males had more than double the prevalence compared to females. Outside drink consumption showed an unexpected association in bivariate analysis ($p<0.001$). It was excluded from the final adjusted model due to potential misclassification due to social desirability bias. Lower fruit & vegetable consumption was associated with higher BP. The association was significant ($p < 0.001$). Underweight status was protective, whereas overweight/obesity did not retain an independent association. Central adiposity (WHtR) showed a significant association in bivariate analysis, but did not retain significance after adjustment. No significant association was found with Family history, Exercise, Sleep, Tobacco use, Alcohol, Stress (borderline significance), or Outside food consumption.

After controlling for multiple variables, Late adolescence, male sex, and BMI status (underweight protective) were independently associated with Raised BP.

Table 1: Association of Blood Pressure Categories with Socio Demographic Status and Anthropometric Measurements of Study Participants (N=270)

Characteristic		n (%)	Normal	Elevated BP	Grade I /Grade 2 Hypertension	P value
Age (In completed Years)	10-14	67	54 (37.8)	10 (8.8)	3 (23.1)	<0.001
	15-19	139	47 (34.3)	82 (71.9)	8 (61.5)	
	20-24	64	40 (28.0)	22 (19.3)	2 (15.4)	
Gender	Male	95	28 (19.6)	61 (53.5)	6 (46.2)	<0.001
	Female	175	113 (80.4)	53 (46.5)	7 (53.8)	
Socio economic status	Class I	22	12 (8.4)	10 (8.8)	0 (0)	<0.01
	Class II	18	3 (2.1)	12 (10.5)	3 (23.1)	
	Class III	89	42 (29.4)	44 (38.6)	3 (23.1)	
	Class IV	111	67 (46.9)	40 (35.1)	4 (30.8)	
	Class V	30	19 (13.3)	8 (7.0)	3 (23.1)	
BMI	Underweight	120	85 (59.4)	29 (25.4)	6 (46.2)	<0.01
	Normal	103	40 (28.0)	59 (51.8)	4 (30.8)	
	Overweight	35	12 (8.4)	20 (17.5)	3 (23.1)	
	Obese	12	6 (4.2)	6 (5.3)	0 (0)	
Waist Height Ratio	No/ Low Risk	202	118 (82.5)	76 (66.7)	8 (61.5)	<0.01
	High Risk	58	21 (14.9)	32 (28.1)	5 (38.5)	
	Very High Risk	10	2 (2.8)	6 (5.3)	0 (0)	

Note: Percentages are column-wise proportions. P values were calculated using Chi-square test and Fisher's Exact Test

Table 2: Association of Blood Pressure Categories with Lifestyle and Family History among study participants (N=270)

Characteristic		n (%)	Normal	Elevated	Grade I /Grade 2 Hypertension	P value
Outside Drinks	Daily	55	31 (21.7)	23 (20.2)	1 (7.7)	<0.01
	Frequently	100	73 (51.0)	21 (18.4)	6 (46.2)	
	Occasionally	70	23 (16.1)	43 (37.7)	4 (30.8)	
	Rarely	45	16 (11.2)	27 (23.7)	1 (7.7)	
Outside Food	High	40	17 (11.9)	23 (20.2)	0 (0)	0.065
	Moderate	158	83 (58.0)	62 (54.4)	13 (100)	
	Low	72	40 (30.1)	29 (25.4)	0 (0)	
Fruits and Vegetables	2-3 days/ week	92	29 (20.3)	57(50.0)	6 (46.2)	<0.01
	4-6 days/ week	63	32 (22.4)	28 (24.6)	3 (23.1)	
	Daily	115	80 (57.3)	29 (25.4)	4 (30.8)	
Exercise	Daily	24	12 (8.4)	11 (9.6)	1 (7.7)	0.083
	Sometimes	137	74 (51.7)	55 (48.2)	8 (61.5)	
	Never	109	57 (39.9)	48 (42.1)	4 (30.8)	
Tobacco	No	261	139 (97.2)	110 (96.5)	12 (92.3)	0.067
	Yes	9	4 (2.8)	4 (3.5)	1 (7.7)	
Alcohol	No	267	143 (100)	112 (98.2)	12 (92.3)	0.926
	Yes	3	0 (0)	2 (1.8)	1 (7.7)	
Adequate Sleep	Yes	170	88 (61.5)	75 (65.8)	7 (53.8)	0.532
	No	100	55 (38.5)	39(34.2)	6 (46.2)	
Stress	Absent	173	96 (67.1)	67 (58.8)	10 (76.9)	0.063
	Present	97	44 (32.9)	47 (41.2)	3 (23.1)	
Family History of Hypertension	No	248	130 (90.9)	104 (91.2)	12 (92.3)	0.187
	Yes	22	13 (9.1)	10 (8.8)	1 (7.7)	

Note: Percentages are column-wise proportions. P values were calculated using Chi-square test and Fisher's Exact Test

Table 3: Multivariate Analysis for Determinants of Raised Blood Pressure (Elevated BP and Hypertension) in the study population (N= 270)

Characteristic		aOR	95% CI	P Value
Age (In completed Years)	10-14	Ref		
	15-19	4.77	2.06-11.04	<0.001
	20-24	0.60	0.21-1.73	0.347
Gender	Female	Ref		
	Male	2.43	1.07-5.49	0.033
BMI	Normal	Ref		
	Underweight	0.31	0.16-0.61	<0.001
	Overweight/ Obese	0.88	0.33-2.34	0.798
WHR	No Increased risk	Ref		

Increased Risk/ Very High Risk	0.89	0.36-2.17	0.80

Note: Outside drink consumption was not included in the final multivariable model because it was self-reported, prone to misclassification, and showed unstable category-wise distribution, which could lead to residual confounding. WHtR categories were merged due to sparse observations

DISCUSSION

The above study aimed to determine the prevalence of Raised Blood Pressure among adolescents and Youth in Rural area of Varanasi.

The findings highlight a substantial burden of Raised blood pressure (47.0%), with nearly half of the participants exhibiting Elevated BP or Hypertension on screening. The prevalence of Hypertension alone was 4.9%. The prevalence of Raised Blood Pressure observed in the present study is higher than that reported in several earlier Indian studies but is consistent with emerging evidence that Raised BP is becoming increasingly common. A nationally representative analysis from the Comprehensive National Nutrition Survey (CNNS) reported a prevalence of high blood pressure of 35.1% among younger adolescents aged 10-12 years using the 2017 American Academy of Pediatrics (AAP) criteria, indicating that elevated BP may be substantially under-recognized in younger age groups.(10)

Community-based evidence from rural North India further supports these findings. Sumna VM et al., in a cross-sectional study conducted in Ballabgarh, Haryana, reported an overall hypertension prevalence of 18.9% among adolescents aged 10-19 years using age-appropriate AAP/IAP criteria.(8) Daniel et al. reported a pooled hypertension prevalence of approximately 7-8% among Indian adolescents.(9) While the current study reports Hypertension prevalence as 4.9%, a significant burden of Elevated BP suggests it is no longer confined to urban populations and may reflect ongoing lifestyle and nutritional transitions even in rural settings.

Raised BP was most prevalent in late adolescence (15-19 years), and this age group emerged as the strongest independent predictor even after adjustment for confounders. Similar age-related increase in adolescent BP have been reported in Indian studies, which might reflect the combined influence of pubertal hormonal changes, increasing psychosocial stress, and early adoption of unhealthy dietary behaviours during late adolescence. The importance of this finding is reinforced by evidence of BP tracking across the life course. Chen and Wang, in their systematic review, demonstrated that raised blood pressure in childhood and adolescence strongly predicts hypertension in adulthood, emphasizing adolescence as a critical period for early prevention.(2)

Male participants had significantly higher odds of Raised BP compared to females. This gender differential has been consistently reported in Indian and global studies, including the CNNS findings, where boys showed a higher prevalence than girls.(10) Possible explanations include differences in hormonal profiles, body composition, dietary habits, and greater exposure to behavioral risk factors among males.

It was seen that underweight participants had significantly lower odds of Raised BP compared to those with normal BMI, while overweight/obesity did not retain an independent association after adjustment. The protective effect of underweight is biologically plausible and has been observed in other Indian adolescent datasets, where BP rises progressively with increasing adiposity. CNNS findings similarly demonstrate higher prevalence of Hypertension among adolescents with greater BMI. (7) Sumna VM et al. also reported increased odds of Hypertension among adolescents with higher BMI in rural North India.(8) Study by Ranjani et al. also reported increasing cardiovascular risk with higher adiposity.(7)

Inadequate consumption of fruits and vegetables showed a positive association with Raised BP, although statistical significance was attenuated after adjustment. Other lifestyle factors such as physical activity, sleep duration, tobacco use, alcohol consumption, and family history did not show statistically significant associations in the adjusted analysis. The lack of significance may reflect low exposure prevalence or underreporting due to social desirability bias.

The findings indicate that Raised BP is emerging as an important public health concern among adolescents and youth even in rural India. The consistency of findings with other rural North Indian evidence, underscores the need for early cardiovascular risk screening and prevention strategies beyond urban settings.

CONCLUSION

A high prevalence of Raised Blood Pressure, predominantly in the form of Elevated BP, was observed among adolescents and youth aged 10-24 years in rural Varanasi. Late adolescence, male sex, and higher body mass index emerged as independent determinants. These findings indicate that hypertension is no longer confined to adulthood and is emerging as an important public health concern even in rural adolescent populations.

RECOMMENDATION

Based on the study findings it is recommended that routine blood pressure screening should be integrated into school and college health services to enable early identification of Raised blood pressure. Existing adolescent health platforms, particularly the Rashtriya Kishor Swasthya Karyakram (RKSK) and initiatives addressing both school, and out-of School adolescents, should be strengthened to include regular monitoring of blood pressure, body mass index, and lifestyle risk factors. Targeted interventions focusing on healthy dietary practices, prevention of unhealthy weight gain, and promotion of physical activity should be initiated during early and mid-adolescence. Capacity building of frontline health workers and school health teams for adolescent-friendly NCD screening is essential. Longitudinal studies are recommended to understand the progression of elevated blood pressure from adolescence into adulthood and to evaluate the effectiveness of early preventive interventions.

Limitation of the Study

The cross-sectional design precludes causal inference. Blood pressure was measured during a single visit, which may overestimate prevalence due to transient BP elevations. Lifestyle and dietary variables were self-reported and subject to recall and social desirability bias. Additionally, the study included only school- and college-going youth, limiting generalizability to out-of-school adolescents. Pubertal status and salt intake, which may influence adolescent blood pressure, could not be assessed.

Relevance of the Study

Adolescence represents a critical window for prevention of adult hypertension, yet evidence from rural low and middle-income settings is scarce. This study contributes rural Indian data on Raised blood pressure prevalence and determinants, informing early-life NCD prevention strategies applicable to similar resource-limited settings.

Authors Contribution

All authors have contributed equally.

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Nil

Conflict of Interest

There are no conflicts of interest.

Declaration of Generative AI and AI Assisted Technologies in the Writing Process

Artificial intelligence tools (ChatGPT, OpenAI) were used to assist with language editing, formatting, and improving clarity of the manuscript. All data analysis, interpretation of results, and scientific content were performed by the authors. The authors take full responsibility for the final submitted version of the manuscript.

References

1. Song P, Zhang Y, Yu J, et al. Global prevalence of hypertension in children and adolescents: a meta-analysis. JAMA Pediatr. 2019;173(12):1154-63.
2. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: a systematic review and meta-regression analysis. Circulation. 2008;117(25):3171-80.
3. Juonala M, et al. Childhood cardiovascular risk factors and adult cardiovascular events. N Engl J Med. 2011;365(20):1876-85.
4. World Health Organization. Global status report on noncommunicable diseases 2014. Geneva: WHO; 2014.
5. GBD 2019 Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990–2019. Lancet. 2020;396(10258):1223-49.
6. International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-5), 2019-21: India. Mumbai: IIPS; 2021.
7. Ranjani H, et al. Epidemiology of childhood overweight and obesity in India. Indian J Endocrinol Metab. 2016;20(4):489-97
8. Sumna VM, Malhotra S, Gupta S, Goswami K, Salve HR, et al. Prevalence and associated factors of hypertension among adolescents in a rural community of North India. Cureus. 2023 Oct 29;15(10):e47934. doi:10.7759/cureus.47934
9. Daniel RA, et al. Prevalence of hypertension among adolescents (10-19 years) in India: a systematic review and meta-analysis. PLoS One. 2020;15(10):e0239929.
10. Vasudevan A, Thomas T, Kurpad AV, et al. Prevalence of high blood pressure among children and adolescents aged 10-19 years in India: findings from the Comprehensive National Nutrition Survey. *Prev Med*.2022;154:106878. doi:10.1016/j.ypmed.2021.106878.