

Original Research Article

Prevalence of hypertension in high school children in urban and rural regions of Telangana: a cross-sectional comparative study

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Received: 06 September 2026

Accepted: 18 October 2026

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ABSTRACT

Background: Hypertension (HTN) is increasingly recognised as a paediatric concern with significant long-term cardiovascular implications. This study aimed to assess and compare the prevalence of HTN among high school children in the urban and rural settings of Telangana and to identify associated modifiable risk factors.

Methods: A cross-sectional, school-based study was conducted from January to December 2025 across four government and four private high schools each in urban (Hyderabad) and rural (Sadasivapet) regions. A total of 1200 students aged 13-15 years were enrolled using multistage random sampling. Data were collected through a pretested structured questionnaire and standardised anthropometric and blood pressure measurements. Statistical analysis was performed using statistical package for the social sciences (SPSS) version 26.

Results: The overall prevalence of hypertension was 11.5%. Urban prevalence (14.2%) was significantly higher than rural prevalence (8.2%). A significant association was observed between elevated blood pressure and higher BMI ($p < 0.01$), reduced physical activity ($p < 0.05$), and frequent junk food consumption ($p < 0.05$).

Conclusions: Hypertension is a prevalent, under-recognised condition among Telangana adolescents, with a disproportionate urban burden. Preventive strategies targeting modifiable risk factors through school-based screening and health education are warranted.

Keywords: Hypertension, Adolescents, Urban-rural, Prevalence, Telangana, School children

INTRODUCTION

Non-communicable diseases (NCDs) now account for the majority of the global disease burden, and cardiovascular disease sits at the centre of this transition. Hypertension, long regarded as a disorder of adulthood, is one of the most important modifiable contributors to cardiovascular morbidity worldwide, and its origins are now understood to extend well into the paediatric years.

Within this broader NCD landscape, elevated blood pressure (BP) in children and adolescents has emerged as a distinct area of concern. Unlike adult hypertension,

paediatric hypertension is frequently asymptomatic and therefore under-detected in routine practice, yet longitudinal evidence indicates that elevated BP in childhood is a strong predictor of adult hypertension and subsequent cardiovascular disease.^{1,2} This tracking phenomenon underscores the importance of early identification rather than treatment of established disease later in life.

Narrowing further to aetiology, paediatric hypertension is understood to be multifactorial, arising from the interaction of genetic predisposition with behavioural and environmental influences such as poor dietary habits, physical inactivity, increased screen time, and

psychosocial stress.^{3,4} The working group of the national high blood pressure education program has formalised age-, sex-, and height-specific percentile criteria that now form the basis for classifying children as normotensive, prehypertensive, or hypertensive.⁴ Superimposed on this individual-level risk architecture is a global epidemiological shift: the World Health Organization (WHO) estimates that one in five children worldwide is overweight or obese, a substantial proportion of whom are at heightened risk of developing hypertension.⁴

Focusing specifically on the Indian context, this burden is expanding in both urban and rural settings, although the underlying risk-factor patterns and magnitude of prevalence differ considerably by geography. Recent Indian data suggest that a sizeable minority of adolescents nationally have elevated blood pressure, with consistently higher prevalence reported from urban centres compared with rural areas.^{5,16,17} Urbanisation, dietary transition towards calorie dense processed foods, sedentary behaviour, increased academic pressure, and reduced outdoor activity have all been implicated in this rising urban-rural gap.⁶

Despite this accumulating evidence, blood pressure monitoring in children continues to be overlooked in routine clinical practice and school health programmes across India, and region-specific data from Telangana, encompassing both metropolitan Hyderabad and its rural periphery, remain sparse. This gap is of particular relevance given that risk-factor profiles, dietary patterns, and healthcare access can vary considerably even within a single state. Narrowing to the specific objective of this work, the present study was therefore designed to estimate and compare the prevalence of hypertension among high school children aged 13 to 15 years in urban (Hyderabad) and rural (Sadasivapet) regions of Telangana, and to examine the association of blood pressure with modifiable risk factors including BMI, physical activity, and junk food consumption.

METHODS

Study design and setting

This was a cross-sectional, school-based observational study conducted over a twelve-month period, from January to December 2025, in the urban region of Hyderabad and the rural region of Sadasivapet, Telangana. The two sites were purposively selected to represent contrasting levels of urbanisation, dietary access, and lifestyle exposure within the same state, thereby allowing a meaningful urban-rural comparison while minimising confounding due to broader socio-cultural or linguistic variation.

Study population and eligibility criteria

Students aged 13 to 15 years, studying in classes VIII to X in the selected schools and willing to provide written informed parental/guardian consent along with student

assent, were eligible for inclusion. Children with a pre-existing diagnosis of renal disease, congenital or acquired cardiac disease, endocrine disorders known to affect blood pressure, or those already on antihypertensive medication were excluded, as were students who were absent on the day of data collection and could not be traced within the study period.

Sample size and sampling technique

The sample size of 1200 was derived from prevalence estimates reported in earlier Indian school-based studies, assuming a 95% confidence level, an anticipated prevalence in the range of 10-12%, and a 5% absolute margin of error, with an additional allowance for nonresponse and incomplete records.^{1,7} Multistage random sampling was employed: at the first stage, four government and four private high schools were randomly selected from a sampling frame of eligible schools in each of the urban and rural sites; at the second stage, classes within each selected school were randomly chosen; and at the third stage, students within the selected classes were enrolled using simple random sampling until the calculated sample size per site was achieved, yielding 600 students each from the urban and rural strata.

Data collection tools

A pretested, semi-structured questionnaire, piloted on a small non-study sample and refined for clarity and cultural appropriateness, was used to collect information on sociodemographic characteristics, dietary habits (including frequency of junk food consumption), physical activity patterns, screen time, and family history of hypertension. The questionnaire was administered by trained investigators in a private setting within each school to encourage honest reporting.

Anthropometric and blood pressure measurement

Height was measured to the nearest 0.1 cm using a stadiometer with the child standing barefoot in the Frankfurt plane, and weight was recorded to the nearest 0.1 kg using a calibrated digital weighing scale with participants in light clothing. Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared and classified into normal, overweight, and obese categories using WHO age- and sex-specific growth reference charts for adolescents.

Blood pressure was measured on the right arm in a seated position after a minimum of five minutes of rest, using a mercury sphygmomanometer with an appropriately sized cuff, following standard auscultatory technique. Three readings were taken at five-minute intervals, and the average of the last two readings was used for analysis, in accordance with standard protocol. Hypertension, prehypertension, and normal blood pressure were classified according to the age-, sex-, and height-specific percentile criteria of the national high blood pressure

education program working group on high blood pressure in children and adolescents.⁴

Ethical considerations

The study protocol was reviewed and approved by the institutional ethics committee prior to commencement. Written informed consent was obtained from parents or legal guardians of all participants, and assent was additionally obtained from the students themselves. Confidentiality of individual data was maintained throughout, and students found to have elevated blood pressure on screening were referred to the nearest healthcare facility for further evaluation and follow-up.

Statistical analysis

Data were entered and analysed using statistical package for the social sciences (SPSS) version 26. Descriptive statistics (means, standard deviations, frequencies, and percentages) were used to summarise demographic and clinical characteristics. The Chi-square test was used to assess associations between categorical variables, including BP classification with sex, residence, BMI category, and lifestyle factors. Multivariate logistic regression was used to identify independent predictors of hypertension after adjusting for potential confounders. A two-tailed p value of less than 0.05 was considered statistically significant throughout.

RESULTS

A total of 1200 students participated in the study, with equal representation of 600 students each from the urban and rural sites. Boys constituted 52.0% of the sample and girls 48.0%, with an overall mean age of 14.0 ± 0.6 years. Urban students were marginally older (mean 14.1 ± 0.6 years) than their rural counterparts (mean 13.9 ± 0.5 years).

The overall prevalence of hypertension in the combined sample was 11.5%. A clear urban-rural gradient was evident: urban students recorded a hypertension prevalence of 14.2%, compared with 8.2% among rural students, a difference that was statistically significant. Prehypertension was observed in 6.9% of the total sample.

Body mass index showed a strong, graded association with blood pressure status. Whereas only 10.8% of students with normal BMI were hypertensive, this proportion rose to 33.5% among overweight students and to 58.7% among obese students, a highly significant trend ($p < 0.01$).

Lifestyle factors were similarly influential. Students who engaged in regular physical exercise had a markedly lower prevalence of elevated blood pressure (14.8%) compared with the significant proportion of physically inactive students affected. Frequent junk food consumption (three or more times weekly) was likewise associated with a substantially higher prevalence of elevated blood pressure (27.6%) than infrequent consumption.

Table 1: Demographic characteristics of study participants.

Variab-le	Urban (n=600)	Rural (n=600)	Total (n=1200)
Boys	308 (51.3%)	316 (52.7%)	624 (52.0%)
Girls	292 (48.7%)	284 (47.3%)	576 (48.0%)
Mean age (years)	14.1 ± 0.6	13.9 ± 0.5	14.0 ± 0.6

Table 2: Blood pressure classification by residence.

Classification	Urban (n=600)	Rural (n=600)	Total (n=1200)
Normal	470	513	983
Prehyper-tensive	45	38	83
Hypertensive	85	49	134

Table 3: Association between BMI category and blood pressure status.

BMI category	Normal BP (%)	Elevated BP (%)	P value
Normal	89.2	10.8	<0.05
Overweight	66.5	33.5	<0.01
Obese	41.3	58.7	<0.01

Table 4: Lifestyle factors and blood pressure status.

Factor	Normal BP (%)	Elevated BP (%)	P value
Regular exercise	85.2	14.8	<0.05
Junk food $\geq 3 \times$/week	72.4	27.6	<0.01

DISCUSSION

The present study found an overall hypertension prevalence of 11.5% among 13-15-year-old adolescents in Telangana, with a markedly higher burden in the urban site (14.2%) compared with the rural site (8.2%). This urban-rural gradient is consistent with the broader Indian literature. Anand et al first documented a rising trend of paediatric hypertension in urban Indian schoolchildren, and Verma et al similarly reported a higher burden of hypertension linked to obesity in urban cohorts.^{1,2} More recent large-scale Indian data reinforce this pattern: Mohan et al in a school-based study from North India, reported significantly higher sustained hypertension and obesity among urban compared with rural adolescents, while Vasudevan et al drawing on a nationally representative adolescent sample, similarly documented a higher burden of elevated blood pressure in urban settings.^{16,17} Our urban prevalence estimate of 14.2% sits within the range reported by these Indian studies, while the rural estimate of 8.2% is broadly comparable to rural figures reported in the six-state multicentre study by Vispute et al.¹⁸

The strength of the urban-rural gap observed here is also mirrored outside India: a large cross-sectional study of over 13,000 children in south-west China reported a comparable urban rural disparity in childhood hypertension, and attributed this gradient to differences in obesity prevalence, maternal factors, and household income between settings, echoing our own findings on the centrality of BMI.¹⁹ Nonetheless, the literature is not entirely uniform in this direction: a study conducted among adolescents in urban slums of Nagpur reported prehypertension and hypertension rates similar to or exceeding some rural estimates, illustrating that urban poverty pockets do not always follow the same risk profile as more affluent urban cohorts, and that within-urban heterogeneity deserves closer future attention.²⁰

Urban adolescents in our study displayed higher exposure to established behavioural risk factors, notably reduced physical activity and greater intake of calorie-dense, processed foods, reinforcing the role of environmental and behavioural determinants in blood pressure regulation during adolescence.³ According to WHO estimates, the global rise in childhood obesity is a principal driver of this early-onset hypertension epidemic, and our data, in which fewer than 11% of normal-weight students were hypertensive compared with nearly 59% of obese students, provide strong local confirmation of this relationship.⁴

The BMI-blood pressure association observed in our cohort aligns closely with the wider literature. Ogden et al demonstrated that increasing BMI directly correlates with cardiovascular risk in children in the United States, while Gupta et al established a comparable relationship between adiposity and paediatric hypertension in an Indian population.^{5,6} The landmark Muscatine study by Lauer and Clarke further showed that childhood obesity predicts elevated blood pressure in adulthood, lending longitudinal weight to what is otherwise a cross-sectional association in

the present study.⁷ Sorof et al additionally highlighted the influence of ethnicity and lifestyle on school-aged hypertension in a manner consistent with the demographic profile of our cohort, and Bao et al demonstrated that BP tracks from childhood into adulthood as a reliable predictor of essential hypertension, underscoring the long-term clinical relevance of even modest elevations detected at school age.^{8,9}

Beyond BMI, our findings on vascular and structural implications are supported by Raitakari et al who documented early vascular changes in obese children, and by Daniels et al who observed early cardiac remodelling among hypertensive adolescents, both emphasising the importance of early detection over reactive management.^{10,11} Falkner et al cautioned that even prehypertension, present in 6.9% of our sample, should not be dismissed as clinically insignificant, since it frequently progresses to sustained hypertension if unaddressed.¹²

The role of dietary and lifestyle modification is reinforced by Raj et al who demonstrated a direct impact of lifestyle change on cardiometabolic risk in Indian children, while Jain et al reported broadly comparable prevalence patterns among school-going children in northern India, supporting the generalisability of our urban-rural findings beyond Telangana.^{13,14} Mungreiphy et al further emphasised regional and ethnic variation in the BMI-blood pressure relationship among tribal adolescents, a reminder that risk-factor associations, while broadly consistent in direction, can vary in magnitude across India's diverse populations, and that region-specific data such as those generated by the present study remain valuable for local policy planning.¹⁵

Taken together, this body of comparative evidence situates our Telangana-specific findings within a well-established and expanding Indian and international literature on adolescent hypertension: the consistent urban excess, the strong graded relationship with BMI, and the modifiable nature of the principal risk factors identified. This convergence strengthens confidence that the associations observed in our cohort reflect genuine underlying relationships rather than chance findings specific to our sample.

This study has certain limitations. Its cross-sectional design precludes causal inference regarding the temporal relationship between risk factors and hypertension. Reliance on self-reported dietary and physical activity data may have introduced recall or social desirability bias. The use of mercury sphygmomanometer, while standard and validated, requires meticulous technique, and single-day BP measurement, despite averaging of the last two of three readings, does not fully account for the confirmatory office visits recommended in some paediatric BP guidelines. Future longitudinal studies with repeated BP measurements and objective activity monitoring would help clarify causal pathways.

Collectively, our findings underscore the pressing need for early detection and intervention through school-based BP

screening, structured nutrition education, and initiatives to promote physical activity, particularly in urban schools. A holistic, community-linked approach involving clinicians, educators, and policymakers is essential to curb the long-term cardiovascular consequences of untreated adolescent hypertension.

CONCLUSION

Hypertension is an emerging and under-recognised concern among adolescents in Telangana, with a disproportionately higher burden in urban compared with rural settings. The strong, graded association with BMI, together with the significant contributions of physical inactivity and frequent junk food consumption, highlights modifiable targets for intervention. Regular school-based blood pressure screening, integration of nutrition and physical activity education into the school curriculum, and active family engagement are essential components of a comprehensive strategy to reduce the burden of adolescent hypertension and its long-term cardiovascular sequelae.

ACKNOWLEDGEMENTS

Authors would like to thank the school administrations, teachers, students, and their parents/guardians for their cooperation and participation in this study, and the field investigators for their assistance with data collection.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Husain A, Singh K, Khadervali N, Dixit K. Prevalence of hypertension in high school children in urban and rural regions of Telangana: a cross-sectional comparative study. *Int J Community Med Public Health* 2026;13:6798-802.