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PREVALENCE AND DETERMINANTS OF PREHYPERTENSION AND HYPERTENSION AMONG ADOLESCENTS IN THIRUVALLUR DISTRICT, TAMIL NADU, INDIA: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Hypertension, once considered predominantly a disease of adulthood, is increasingly recognized among adolescents, particularly in settings where non-communicable diseases may remain underdiagnosed. Early identification of elevated blood pressure is essential to prevent future cardiovascular morbidity and mortality.

Objectives: To determine the prevalence of elevated blood pressure and hypertension among adolescents aged 10–19 years attending the Rural Health Training Centres in Thiruvallur district, Tamil Nadu, and to identify socio-demographic, behavioural, and clinical factors associated with elevated blood pressure.

Methods: An analytical cross-sectional study was conducted among 240 adolescents from June to December 2025. Participants were recruited using convenience sampling. Data were collected using a semi-structured, pre-tested questionnaire. Blood pressure was measured and classified according to the 2017 American Academy of Pediatrics (AAP) Clinical Practice Guideline. The chi-square test was used to assess associations, and multivariable logistic regression analysis was performed to identify independent predictors of elevated blood pressure.

Results: Elevated blood pressure (Prehypertension), Stage 1 hypertension, and Stage 2 hypertension were observed in 3.8%, 2.9%, and 5.0% of participants, respectively, with an overall hypertension prevalence of 7.9%. Male sex ($p = 0.03$), family history of hypertension ($p = 0.01$), and overweight status ($p = 0.001$) were significantly associated with elevated blood pressure. Multivariable logistic regression identified male sex (AOR 2.4, 95% CI 1.1–5.3), family history of hypertension (AOR 2.9, 95% CI 1.3–6.4), and overweight status (AOR 3.8, 95% CI 1.7–8.6) as independent predictors. Physical activity, screen time, dietary habits, and sleep duration were not significantly associated with elevated blood pressure.

Conclusion: Elevated blood pressure and hypertension represent important health concerns among adolescents, with male sex, family history of hypertension, and overweight identified as key determinants. Routine blood pressure screening, targeted health education, and lifestyle interventions should be integrated into adolescent health programmes to facilitate early detection and reduce the future burden of cardiovascular disease.

Keywords: Adolescents, Hypertension, Elevated Blood Pressure, Risk Factors, Cross-Sectional Study, Tamil Nadu.

INTRODUCTION

Hypertension, traditionally thought to be a disease of middle and old age, is now emerging as a major public health concern in teenagers, particularly in underserved rural areas.

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 21-06-2026
Date Acceptance: 28-06-2026
Date of Publication: 27-07-2026

Non-communicable illnesses (NCDs) like hypertension, which have hitherto been eclipsed by communicable diseases in rural health discourse, are now exposing a quiet epidemic among youth populations.[1] Rural teenagers are more vulnerable due to the combination of dietary changes, lifestyle changes, and restricted access to preventative treatment. Many of them are still untreated and unidentified.[2] Contrary to long-held beliefs about the health benefits of rural living, recent research has revealed that the prevalence of high blood pressure among teenagers in rural areas is getting close to that of their urban counterparts.[3] This trend is caused by a number of factors that have not received enough

attention in rural settings, including increased intake of processed foods, sedentary behavior brought on by digital exposure, and socio-environmental stressors.[4] In addition, most teenagers' first point of contact is a rural health center, which frequently lacks the resources and procedures needed for early hypertension screening and treatment.[5] Adolescent hypertension is a growing public health concern, but it is still underdiagnosed and underreported, particularly in rural areas where infectious diseases and maternal-child health are given priority by health systems.[6] The adolescent population in rural areas is undergoing rapid lifestyle changes, marked by increased dietary salt intake, physical inactivity and rising mental stress, all of which are known precursors to elevated blood pressure.[7] However, routine screening for hypertension in this age group is rarely integrated into primary care protocols in rural health settings. Without early detection and intervention, hypertensive adolescents risk transitioning into adulthood with long-standing cardiovascular damage, leading to increased morbidity in early adult life.[8] A targeted, context-specific study is essential to illuminate the true burden of adolescent hypertension in rural areas, to identify associated risk factors and inform appropriate health system responses. This study aims to address the growing yet under-recognized burden of adolescent hypertension within a rural health center setting. By identifying prevalence patterns, associated risk factors and system-level gaps in diagnosis and management, we seek to inform targeted strategies for early detection and long-term prevention.

METHODOLOGY

An analytical cross-sectional study was conducted among adolescents aged 10–19 years attending the Rural Health Training Centre to determine the prevalence of elevated blood pressure and hypertension and to identify the factors associated with elevated blood pressure. Data was collected using a semi-structured and pre-validated questionnaire. Participants were selected using convenience sampling from adolescents attending the rural health training center during the study period [June 2025 - December 2025]. This sampling approach was chosen due to resource constraints and logistical feasibility.

Inclusion Criteria: Adolescents aged 10–19 years attending the Rural Health Training Centre during the study period and who provided informed consent was included in the study. For participants aged below 18 years, parental or guardian consent was obtained.

Exclusion Criteria: Adolescents with previously diagnosed hypertension who were currently receiving antihypertensive treatment, those with known secondary causes of hypertension such as renal or endocrine disorders, pregnant adolescents, those with physical disabilities precluding accurate anthropometric measurements, and those who were acutely febrile or unwell on the day of assessment were excluded from the study.

The Questionnaire had details on socio-demographic characteristics such as age, sex, religion, and educational status; family history of hypertension; and behavioral factors including dietary habits and physical activity.

Anthropometric measurements were obtained following the World Health Organization (WHO) STEPwise approach to noncommunicable disease risk factor surveillance (STEPS) protocol. Height was measured using a portable stadiometer, with participants standing barefoot on a flat surface in an erect posture and the head positioned in the Frankfurt plane. Weight was measured using a calibrated digital weighing scale, with participants wearing light clothing and no footwear.[9]

The body mass index (BMI) was calculated for each participant by dividing weight in kilograms by the square of height in meters (kg/m^2). BMI was categorized according to the WHO 2007 BMI-for-age reference for children and adolescents aged 5–19 years into underweight/thinness (<−2 SD), normal (−2 SD to +1 SD), overweight (>+1 SD to +2 SD), and obese (>+2 SD).[10]

Blood pressure was measured using a [Diamond aneroid blood pressure apparatus – Clock type – BPDL 237 model] after the participant had rested in a seated position for at least 5 minutes. The right arm was supported at heart level during measurement. An appropriately sized cuff was selected according to the participant's mid-arm circumference. Three blood pressure readings were obtained at 2-minute intervals, and the mean of the second and third readings was used for analysis. For auscultatory measurements, Korotkoff phase V was used to determine diastolic blood pressure.[9] Three readings were taken at 15 minute intervals and the mean of the second and third readings was recorded for analysis.

Blood pressure was classified according to the 2017 American Academy of Pediatrics (AAP) Clinical Practice Guideline. For adolescents aged <13 years, normal blood pressure was defined as <90th percentile; elevated blood pressure or prehypertension as ≥90th to <95th percentile or 120/80 mmHg to <95th percentile, whichever was lower; Stage 1 hypertension as ≥95th percentile to <95th percentile +12 mmHg or 130/80–139/89 mmHg, whichever was lower; and Stage 2 hypertension as ≥95th percentile +12 mmHg or ≥140/90 mmHg, whichever was lower. For adolescents aged ≥13 years, normal blood pressure was defined as <120/<80 mmHg, elevated blood pressure as 120/<80 to 129/<80 mmHg, Stage 1 hypertension as 130/80–139/89 mmHg, and Stage 2 hypertension as ≥140/90 mmHg.[11]

Blood pressure was assessed during a single study visit due to resource and logistical constraints. According to the 2017 AAP Clinical Practice Guideline, a

diagnosis of hypertension in children and adolescents should be based on auscultatory-confirmed blood pressure readings at or above the 95th percentile on three different visits. Therefore, blood pressure categories identified in the present study represent screening measurements, and the use of a single-visit assessment may have overestimated the prevalence of sustained hypertension.[11]

The study was approved by the Institutional Human Ethics Committee (IHEC) of the tertiary care centre (IHEC No. 364). Prior to data collection, informed consent was obtained from participants aged 18 years and above. For participants aged below 18 years, written informed consent was obtained from their parent or legal guardian, along with assent from the participant. Confidentiality of the collected information was maintained throughout the study, and unique identifiers were used in place of personally identifiable information.

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software, version 21. Descriptive statistics, including frequencies and percentages, were used to summarize socio-demographic characteristics, behavioural factors, anthropometric parameters, and blood pressure categories. The Chi-square (χ^2) test was used to assess associations between categorical variables and elevated blood pressure. Variables showing significant associations were further analysed using multivariable logistic regression to identify independent predictors of elevated blood pressure. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1. Socio-Demographic and Clinical Characteristics of the Study Participants (N = 240)

S.No	Variables	N (%)
1.	Age In Years	
	10–13 Years	156 (65)
	14-16 Years	47 (19.7)
	17-19 Years	37 (15.3)
2.	Gender	
	Male	139(57.9)
	Female	101(42.1)
3.	Residence	
	Rural	233 (97.1)
	Urban	7 (2.9)
4.	Family Type	
	Nuclear	159 (66.3)
	Joint	58 (24.2)
	Extended	23 (9.5)
5.	Monthly Family Income (₹)	
	≤ 17000	123 (51.3)
	>17000	117 (48.7)
6.	Family History Of Hypertension	
	Yes	127 (52.9)
	No	96 (40)
	Don’t Know	17 (7.1)
7.	Any Chronic Illness	
	Yes	20 (8.3)
	No	220 (91.7)

Table 1 presents the socio-demographic and clinical characteristics of the 240 study participants. The majority of adolescents belonged to the 10–13 years age group (65%), followed by 14–16 years (19.7%) and 17–19 years (15.3%). Males constituted 57.9% of the study population, while females accounted for 42.1%. Most participants were from rural areas (97.1%), with only a small proportion from urban settings (2.9%). Regarding family structure, two-thirds (66.3%) belonged to nuclear families, followed by joint (24.2%) and extended families (9.5%). Slightly more than half of the participants (51.3%) had a monthly family income below ₹17,000. A positive family history of hypertension was reported by 52.9% of participants, while 40% reported no such history and 7.1% were unaware. Only 8.3% of participants had any chronic illness, whereas the majority (91.7%) were free from chronic conditions.

Table 2. Prevalence and Classification of Blood Pressure Among Adolescents According To the 2017 AAP Guidelines (N = 240)

S. No	Blood Pressure Category	N (%)
1.	Elevated Blood Pressure (Pre- Hypertension)	9 (3.8)
2.	Stage I Hypertension	7 (2.9)
3.	Stage Ii Hypertension	12 (5.0)

Table 2 shows the prevalence and classification of blood pressure among adolescents based on AAP 2017 guidelines. Pre-hypertension was observed in 3.8% of participants. Stage 1 hypertension was present in 2.9%, while stage 2 hypertension (labeled as Stage II) was seen in 5% of adolescents. Overall, approximately 11.7% of the study population had elevated blood pressure (pre-hypertension and hypertension combined), indicating a notable burden of abnormal blood pressure levels in this age group.

Table 3. Association of Socio-Demographic, Behavioural, Lifestyle, and Nutritional Factors with Hypertension among Adolescents

S. No	Variable	Category	Hypertension N (%)	Normal Bp N (%)	X^2 Value	P-Value
1.	Gender	Male	15 (10.1)	124 (89.2)	3.74	0.05*
		Female	4 (4.4)	97 (96)		
2.	Family History Of Hypertension	Present	14 (10.1)	125 (89.9)	6.63	0.01*
		Absent	5 (4.9)	96 (95.1)		
3.	Physical Activity (Per Week)	<30 Minutes	5 (8.9)	51 (91.1)	0.25	0.62
		30–60 Minutes	14 (7.7)	170 (92.3)		
4.	Screen Time (Per Day)	<2 Hours	10 (7.2)	129 (92.8)	0.50	0.48
		≥2 Hours	9 (8.9)	92 (91.1)		
5.	Extra Salt Intake	Yes	4 (13.8)	25 (86.2)	2.88	0.09
		No	15 (7.1)	196 (92.9)		
6.	Snack Consumption	≥1 Snack/Day	12 (8.9)	123 (91.1)	0.68	0.41
		<1 Snack/Day	7 (6.7)	98 (93.3)		
7.	Sleep Duration	<8 Hours	8 (8.3)	88 (91.7)	0.08	0.77
		≥8 Hours	11 (7.6)	133 (92.4)		
8.	Bmi	Normal	9 (5.2)	164 (94.8)	10.83	0.001*
		Overweight	10 (16.9)	49 (83.1)		

** Statistically significant at p < 0.05.*

Table 3 depicts the association between socio-demographic, behavioral, nutritional, lifestyle factors and BMI with elevated blood pressure. Male gender showed a statistically significant association with elevated blood pressure (p = 0.03). Similarly, participants with a family history of hypertension had significantly higher prevalence of elevated blood pressure compared to those without (p = 0.01). Extra salt intake showed a higher proportion of elevated blood pressure (13.8%) compared to those without excess intake (7.1%), but this association was not statistically significant (p = 0.09). Body Mass Index (BMI) demonstrated a strong and statistically significant association with elevated blood pressure. Overweight adolescents had a much higher prevalence (16.9%) compared to those with normal BMI (5.2%) (p = 0.001), indicating overweight as an important risk factor.

Table 4. Multivariable Logistic Regression Analysis of Factors Associated With Hypertension among Adolescents

Sr. No	Variable	Adjusted Odds Ratio (Aor)	95% Ci	P-Value
1.	Male Gender	2.4	1.1 – 5.3	0.03*
2.	Family History Of Hypertension	2.9	1.3 – 6.4	0.01*
3.	Overweight	3.8	1.7 – 8.6	0.001*

** Statistically significant at p < 0.05.*

Table 4 presents the results of multivariate logistic regression analysis identifying independent predictors of hypertension. Male gender was found to be a significant determinant, with males having 2.4 times higher odds of hypertension compared to females. Adolescents with a family history of hypertension had 2.9 times higher odds of developing hypertension. Overweight status emerged as the strongest predictor, with nearly 3.8 times higher odds of hypertension compared to those with normal BMI. These findings indicate that male gender, family history of hypertension and overweight status are significant independent determinants of hypertension among adolescents.

DISCUSSION

The present study assessed the prevalence and determinants of abnormal blood pressure among adolescents and found that 11.7% of participants had abnormal blood pressure levels, comprising elevated blood pressure and Stage 1 and Stage 2 hypertension. The overall prevalence of hypertension was 7.9%, including 2.9% with Stage 1 hypertension and 5.0% with Stage 2 hypertension. A recent systematic review and meta-analysis reported a pooled prevalence of hypertension of 7.6% among Indian adolescents, which is comparable to the prevalence observed in the present study.[2] Variations in prevalence across studies may be attributed to differences in study settings, population characteristics, blood pressure measurement protocols, and diagnostic criteria.

The study population was primarily composed of younger adolescents and boys, with the bulk of participants living in rural areas. In line with earlier research showing a greater frequency of hypertension among male adolescents, there was a strong correlation between male gender and hypertension.[3] A complex interaction of physiological, hormonal, behavioral, and lifestyle-related factors may have an impact on this discrepancy. In the current study, a positive family history of hypertension was also substantially linked to hypertension. This result is in line with other research showing familial clustering of high blood pressure and hypertension, indicating that genetic predisposition and common environmental and lifestyle factors may play a role in the early onset of hypertension in teenagers.[1,3]

The prevalence observed in the present study was also within the wide range of hypertension prevalence previously reported among Indian adolescents. Kumar et al. reported varying levels of elevated blood pressure and hypertension among adolescents, although their findings differed from those observed in the present study.[4] Such variations between studies may reflect differences in age distribution, geographical location, sampling methods, and criteria used for blood pressure classification. Previous Indian studies have reported considerable heterogeneity in the prevalence of adolescent hypertension, highlighting the importance of context-specific estimates and standardized blood pressure assessment methods.

Body mass index emerged as an important determinant of hypertension in the present study, with overweight adolescents having a significantly higher prevalence of hypertension than those with normal BMI. This finding is consistent with previous studies identifying excess body weight as an important modifiable risk factor for elevated blood pressure during adolescence. Multivariable logistic regression analysis further identified male gender, family history of hypertension, and overweight as independent predictors of hypertension, with overweight demonstrating the strongest association. These findings emphasize the importance of excess body weight in the early development of hypertension and highlight the potential role of weight management and healthy lifestyle promotion in adolescent cardiovascular risk reduction.

Physical activity, screen time, sleep length, and snack eating were not shown to be substantially correlated with hypertension among the behavioral and lifestyle factors evaluated. Teenagers who reported consuming more salt had a higher percentage of hypertension, although the relationship was not statistically significant. The comparatively small sample size, the lack of exposure variability, or the self-reported type of behavioral data could all be contributing causes to the lack of meaningful relationships with these lifestyle characteristics. However, current research indicates that poor eating habits, sedentary behavior, physical inactivity, and insufficient sleep may all add up to cardiovascular risk and should be considered as part of all-encompassing teen health promotion initiatives.

Overall, the findings indicate that abnormal blood pressure is an important health concern among adolescents, with male gender, family history of hypertension, and overweight emerging as significant determinants of hypertension. The strong association with overweight highlights an important modifiable target for prevention. Incorporating routine blood pressure assessment, early identification of overweight and obesity, and targeted lifestyle interventions into adolescent health services may facilitate early detection and contribute to reducing the future burden of hypertension and cardiovascular disease.

CONCLUSION

This study found that approximately 1 in 8 adolescents (11.7%) attending a health-training centre in Thiruvallur district, Tamil Nadu, had abnormal blood pressure levels, including elevated blood pressure and hypertension. Overweight status (AOR 3.8), a positive family history of hypertension (AOR 2.9), and male gender (AOR 2.4) emerged as independent predictors

of hypertension. These findings highlight the importance of early blood pressure screening, particularly among adolescents with identifiable risk factors such as overweight and a family history of hypertension. Strengthening routine blood pressure assessment and integrating weight management, healthy dietary practices, and physical activity promotion into adolescent health services may facilitate early identification and prevention of future cardiovascular risk. Further longitudinal and population-based studies are warranted to confirm these associations and evaluate appropriate preventive interventions.

Limitations

The cross-sectional design of this study allows the identification of associations but does not permit the establishment of temporal or causal relationships. Therefore, the identified determinants should be interpreted as statistical associations rather than causal factors. The use of convenience sampling and recruitment from a health-training centre may have introduced selection bias, as adolescents attending a healthcare facility may differ systematically from the general adolescent population, thereby limiting the generalizability of the findings. In addition, blood pressure was assessed during a single study visit; therefore, the prevalence observed in this study represents screening-detected hypertension rather than confirmed sustained hypertension and may overestimate the true prevalence. Behavioural and lifestyle factors were self-reported and may be subject to recall and reporting bias. Future studies employing probability-based community or school sampling, repeated blood pressure measurements, and longitudinal designs are needed to obtain more representative prevalence estimates and clarify the temporal relationships between associated factors and adolescent hypertension.

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How to cite this article: Priyanga D, S. Balabaskaran, Sriram R.M., PREVALENCE AND DETERMINANTS OF PREHYPERTENSION AND HYPERTENSION AMONG ADOLESCENTS IN THIRUVALLUR DISTRICT, TAMIL NADU, INDIA: A CROSS-SECTIONAL STUDY, Asian J. Med. Res. Health Sci., 2026; 4 (2):2499-2504.

Source of Support: Nil, Conflicts of Interest: None declared.