Original Article

Prevalence and Predictive Factors of Elevated Blood Pressure and Hypertension in School-Going Children Aged 6 to 12 Years: A School-Based Cross-Sectional Study

Mayank Patle[1], Kratika Neema[1], Sunita Lakhwani[2], Astha Tiwari[2], Umesh Patel[3]

From, [1]Junior Resident 3rd year, [2]Professor, [3]Professor and HOD, Department of Pediatrics, RKDF Medical College Hospital and Research Center, Bhopal, MP, India

ABSTRACT

Background: Hypertension in children is an emerging public health concern, particularly in urban India, where lifestyle changes are accelerating its burden. Schools offer an efficient platform for large-scale screening. This study aimed to assess the prevalence and predictive factors of Elevated Blood Pressure and hypertension in school-going children aged 6 to 12 years in Bhopal, Madhya Pradesh. **Methods:** A multicentre, school-based, cross-sectional observational study was conducted over 18 months (May 2024 to October 2025) under the Department of Pediatrics of RKDF Medical College Hospital and Research Center, Bhopal. A total of 225 children aged 6–12 years were enrolled from three government and three private schools using a two-stage random sampling method. Blood Pressure was classified using age-, sex-, and height-specific percentiles per American Academy of Pediatrics (AAP) 2017 guidelines. Anthropometric measurements, dietary habits, lifestyle behaviors, sleep duration, and family history were assessed using structured questionnaires. **Results:** Elevated Blood Pressure was observed in 23 children (10.22%): Elevated Blood Pressure in 16 (7.11%), stage 1 hypertension in 6 (2.67%), and stage 2 hypertension in 1 (0.44%). Significant associations were found with age ($p = 0.021$), socioeconomic status ($p = 0.003$), BMI category ($p = 0.001$), school type ($p = 0.041$), physical activity ($p = 0.002$), screen time ($p < 0.0001$), sleep duration ($p = 0.004$), dietary habits ($p < 0.05$), and family history of hypertension, diabetes, cardiovascular disease and renal disease. Renal ultrasonography and Doppler identified renal abnormalities in 3 of the 7 children (42.86%) with confirmed hypertension. **Conclusion:** A notable proportion of school-going children in Bhopal exhibited elevated blood pressure, associated with modifiable lifestyle factors, obesity, higher socioeconomic status, and familial risk. School-based screening and early lifestyle interventions are essential to reduce future cardiovascular risk.

Key words: Child, Hypertension, Blood Pressure, Obesity, Mass Screening.

Hypertension in children is no longer a clinical rarity. Over the past two decades, mounting epidemiological evidence has documented a rightward shift in blood pressure distributions among school-aged children and adolescents, attributable to rising rates of childhood obesity, dietary westernisation, and reduced physical activity [1,2]. Elevated blood pressure in the paediatric age group is now recognised as a significant public health concern with important implications for cardiovascular health in adulthood [3]. The epidemiological transition associated with rapid urbanisation has contributed to a growing burden of paediatric hypertension. School-based studies have documented elevated Blood Pressure and hypertension in 5–20% of children, with considerable variation attributable to regional dietary patterns and socioeconomic status [4,5]. Data from central India and from the state of Madhya Pradesh remain limited, despite the region carrying a substantial population of school-aged children.

Unlike adult hypertension, where absolute fixed thresholds are applied, paediatric hypertension is defined using age-, sex-, and height-specific blood pressure percentiles [6]. Obesity is the strongest predictor of elevated

Access this article online

Received – 30th June 2026
Initial Review – 4th July 2026
Accepted – 22nd July 2026

DOI: 10.32677/ijch.v13i7.8360

Quick response code

Correspondence to: Dr. Mayank Patle , Junior Resident 3rd year, Department of Paediatrics, RKDF Medical College Hospital and Research Centre, Bhopal, India.

Email: Mayankpatle28@gmail.com

blood pressure in children, with excess adiposity increasing sympathetic tone, vascular resistance, and sodium retention [7,8]. Dietary factors, particularly high sodium and sugar intake, sedentary behavior, shortened sleep duration, and positive family history further compound cardiovascular risk [9,10]. This study was designed to assess the Prevalence of Elevated Blood Pressure and hypertension among school-going children aged 6 to 12 years in Bhopal, to identify their predictive factors, and to evaluate renal contributions to hypertension in affected children.

MATERIAL AND METHODS

This was a multicentre, school-based, cross-sectional observational study, carried out over 18 months from May 2024 to October 2025, under the Department of Pediatrics at RKDF Medical College Hospital and Research Center, Bhopal, Madhya Pradesh. Participants were recruited from three government and three private schools in Bhopal. Ethical approval was obtained from the Institutional Ethics Committee (Letter No. RKDFMC/2024/970 dated 30 April 2024). The study was conducted in accordance with the Declaration of Helsinki. Written permission was obtained from the principals of the selected schools, written informed consent from parents, and assent from participating children.

The primary outcome was the prevalence of Elevated Blood Pressure and hypertension among children aged 6–12 years. Secondary outcomes included the identification of demographic, anthropometric, lifestyle, dietary, and familial risk factors, and the evaluation of renal abnormalities using ultrasonography and Doppler in children with confirmed hypertension. Blood pressure and body mass index (BMI) were classified according to the 2017 American Academy of Pediatrics (AAP) and CDC BMI percentile recommendations, respectively [11]. The classification criteria used in the study are presented in Table 1. Study Participants: Children aged 6–12 years enrolled in the selected schools were eligible for inclusion. Children younger than 6 years or older than 12 years, those with acute illness during the preceding 7 days, those receiving continuous medication, and those with chronic or mental illness were excluded from the study.

SAMPLE SIZE AND SAMPLING METHODOLOGY

The minimum required sample size was calculated using the formula $n = Z^2 \times p \times q / d^2$, where $p = 0.5$, $q = 0.5$, $d = 0.05$, and $Z = 1.96$, yielding a minimum of 225 participants. A two-stage random sampling method was employed. In Stage I, three government and three private schools were randomly selected from a complete list obtained from the District Education Office using Stata-generated random numbers. In Stage II, 42 students per school were randomly selected from school rolls. Ineligible or non-consenting students were replaced by the next student on the sorted list.

Table 1: Blood Pressure and BMI Classification Used in the Study

Blood Pressure (AAP 2017)	
Normal blood pressure	< 90th percentile
Elevated Blood Pressure	≥ 90th to < 95th percentile
Stage 1 Hypertension	≥95th percentile to <95th percentile +12 mmHg
Stage 2 Hypertension	≥95th percentile +12 mmHg or ≥140/90 mmHg (whichever is lower)
BODY MASS INDEX (CDC Percentile)	
Normal	5th to <85th percentile
Overweight	85th to <95th percentile
Obese	≥95th percentile

DATA COLLECTION PROCEDURE

Anthropometric measurements were taken by the Principal Investigator under standardized conditions. Weight was measured with a calibrated electronic scale (0.1 kg precision) and height with a stadiometer (0.1 cm precision). BMI was calculated as weight (kg)/height (m^2), and BMI values were classified using CDC recommendations. Blood pressure was measured using a Diamond aneroid (analog) sphygmomanometer with appropriate cuff size (bladder covering 80–100% of arm circumference). The child rested for at least 5 minutes in a seated position with right arm supported at heart level. Korotkoff Phase I was taken as the systolic, and Phase V as the diastolic. A minimum of three readings were taken at each visit. Children identified with elevated blood pressure on initial screening had two additional readings taken on separate occasions before classification. Demographic, dietary, lifestyle, and family history data were collected using a pre-tested, semi-structured questionnaire completed by parents. Incomplete responses were verified by telephone or re-administration. Children confirmed to have hypertension were referred for renal ultrasonography and Doppler studies, performed in the Department of Radiology by a consultant radiologist.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analyzed using Stata version 17.0. Categorical variables were presented as frequencies and percentages; continuous variables as mean ± SD. The prevalence of Elevated Blood Pressure and hypertension was calculated with 95% confidence intervals. Associations between blood pressure status and independent variables were assessed using a chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 225 school-going children aged 6–12 years were enrolled from six schools (three government and three private) in Bhopal. All participants completed clinical assessment and questionnaire-based evaluation. The detailed findings are presented below.

Table 2: Characteristics of Participants

Characteristic	Category	Frequency (n)	Percent (%)
Age (years)	6	23	10.22
	7	22	9.78
	8	34	15.11
	9	46	20.44
	10	34	15.11
	11	37	16.44
	12	29	12.89
Gender	Boy	104	46.22
	Girl	121	53.78
Socioeconomic Status (Kuppuswamy)[12]	Lower	47	20.89
	Upper Lower	44	19.56
	Lower Middle	38	16.89
	Upper Middle	44	19.56
BMI Category (CDC)	Underweight (<5th percentile)	1	0.44
	Normal (5th to <85th percentile)	211	93.78
	Overweight (85th to <95th percentile)	2	0.89
	Obese (≥95th percentile)	11	4.89
	Underweight (<5th percentile)	1	0.44
School Type	Government	86	38.22
	Private	139	61.78

Table 2 presents the baseline characteristics of all 225 participants. Children aged 9 years formed the largest group (20.44%), followed by those aged 11 (16.44%) and 8 and 10 years (15.11% each). Girls were slightly more represented (53.78%). The upper socioeconomic class was the most common category (23.11%). The vast majority (93.78%) had normal BMI, while obesity was present in 11 (4.89%). Most participants attended private schools (61.78%). Table 3 shows the blood pressure status of all 225 participants. Elevated Blood Pressure was present in 23 children (10.22% overall): Elevated Blood Pressure in 16 (7.11%), Stage 1 hypertension in 6 (2.67%), and Stage 2 hypertension in 1 (0.44%). The majority (202; 89.78%) had normal blood pressure. These findings indicate that a notable proportion of school-going children in this cohort experienced early elevations in blood pressure. Table 4 presents the renal ultrasonography and Doppler findings among the 7 children with confirmed hypertension. These results indicate that renal abnormalities were present in a substantial proportion of hypertensive children (42.86%), highlighting the importance of evaluating secondary causes of hypertension in the pediatric age group.

Table 3: Prevalence and Severity of Elevated Blood Pressure

Blood Pressure Status	Frequency (n)	Percentage (%)
Normal blood pressure	202	89.78
Elevated Blood Pressure	16	7.11
Stage 1 Hypertension	6	2.67
Stage 2 Hypertension	1	0.44
Total raised BP (Elevated Blood Pressure + hypertension)	23	10.22

Table 4: Renal Ultrasound and Doppler Findings in Hypertensive Children

Renal USG / Doppler Finding	Frequency (n)	Percent (%)
No abnormality	4	57.1%
Abnormality present	3	42.9%
Total	**7**	**100.00**

Table 5: Determinants of Elevated Blood Pressure: Demographic and Anthropometric Factors

Variable	Normal BP n=202	Normal BP %	Raised BP n=23	Raised BP %	P-value
Age (years)					
6	24	11.9	0	0	0.021
7	24	11.9	0	0	
8	31	15.3	3	13.0	
9	35	17.3	9	39.1	
10	29	14.4	6	26.1	
11	30	14.9	5	21.7	
12	29	14.4	0	0	
Gender					
Boy	95	47.0	9	39.1	0.421 (NS)
Girl	107	53.0	14	60.9	
Socioeconomic Status					
Lower	46	22.8	2	8.7	0.003
Upper Lower	42	20.8	4	17.4	
Lower Middle	34	16.8	4	17.4	
Upper Middle	37	18.3	4	17.4	
Upper Class	43	21.3	9	39.1	
BMI Category (CDC percentiles)					
Underweight	1	0.5	0	0	0.001
Normal weight	195	96.5	16	69.6	
Overweight	0	0	2	8.7	
Obese	6	3.0	5	21.7	
School Type					
Government	84	41.6	2	8.7	0.041
Private	118	58.4	21	91.3	

Table 5 shows the association between Elevated Blood Pressure and demographic and anthropometric variables. Age was significantly associated ($p = 0.021$), with the highest proportion of raised BP at 9 years (39.1%); no cases were seen at ages 6, 7, or 12. Gender showed no significant association ($p = 0.421$). Socioeconomic status was significantly associated with the highest BP burden ($p = 0.003$), with the highest burden in the upper class (39.1%). BMI was strongly associated ($p = 0.001$): obesity was present in 21.7% of the raised BP group versus only 3.0% of those with normal BP, and overweight was exclusively in the raised BP group. School type was significantly associated ($p = 0.041$), with 91.3% of cases of raised BP from private schools. Table 6 presents the association between Elevated Blood Pressure and lifestyle variables. Physical activity was significantly associated ($p = 0.002$), with 56.5% of raised BP cases reporting 1–3 hours/day and none reporting >6 hours. Screen time showed the strongest association ($p < 0.0001$). Sleep duration was significant ($p = 0.004$), with 56.5% of cases with raised BP sleeping <8 hours. Lower fruit and vegetable intake was significantly associated with raised BP

($p < 0.001$): 30.4% of cases with raised BP consumed no fruit or vegetables. Fast food consumption 3–4 times/week was the most common pattern among cases with raised BP (52.2%; $p = 0.014$). High salt food intake 3–4 times/week was most common among cases with raised BP (65.2%; $p = 0.018$). Sugary drink consumption was also significantly associated ($p = 0.021$). Table 7 shows the association between elevated blood pressure and family history of non-communicable diseases. Significant associations were found with family history of hypertension (30.4% vs 21.3%; $p = 0.028$), diabetes (34.8% vs 20.3%; $p = 0.039$), cardiovascular disease (21.7% vs 9.9%; $p = 0.018$), and renal disease (13.0% vs 4.5%; $p = 0.011$). Family history of obesity was numerically higher in the raised BP group (34.8% vs 20.8%) but did not reach statistical significance ($p = 0.062$).

Table 6: Elevated Blood Pressure and Lifestyle Factors

Lifestyle Factor	Normal BP n=202	Normal BP %	Raised BP n=23	Raised BP %	P
Physical Activity (hours/day)					
<1 hour	47	23.3	2	8.7	0.002
1–3 hours	73	36.1	13	56.5	
4–6 hours	49	24.3	8	34.8	
>6 hours	33	16.3	0	0	
Screen Time (hours/day)					
<1 hour	81	40.1	12	52.2	<0.0001
1–2 hours	61	30.2	6	26.1	
2–3 hours	42	20.8	2	8.7	
>3 hours	18	8.9	3	13.0	
Sleep Duration (hours/night)					
<8 hours	70	34.7	13	56.5	0.004
8–10 hours	112	55.4	10	43.5	
>10 hours	20	9.9	0	0	
Fruit & Vegetable Intake (servings/day)					
None	10	5.0	7	30.4	<0.001
1–2 servings	89	44.1	14	60.9	
3–4 servings	90	44.6	2	8.7	
≥5 servings	13	6.4	0	0	
Fast Food Consumption (times/week)					
Never	20	9.9	2	8.7	0.014
1–2 times	71	35.1	7	30.4	
3–4 times	101	50.0	12	52.2	
≥5 times	10	5.0	2	8.7	
High Salt Food Intake (times/week)					
Never	15	7.4	0	0	0.018
1–2 times	85	42.1	6	26.1	
3–4 times	94	46.5	15	65.2	
≥5 times	8	4.0	2	8.7	
Sugary Drink Consumption (times/week)					
Never	11	5.5	3	13.0	0.021
1–2 times	90	44.6	11	47.8	
3–4 times	89	44.1	9	39.1	
≥5 times	12	5.9	0	0	

Table 7: Elevated Blood Pressure and Family History of Non-communicable Diseases

Family History	Normal BP n=202 n	Normal BP %	Raised BP n=23 n	Raised BP %	P-value
Hypertension					
No	159	78.7	16	69.6	0.028
Yes	43	21.3	7	30.4	
Diabetes					
No	161	79.7	15	65.2	0.039
Yes	41	20.3	8	34.8	
Cardiovascular Disease					
No	182	90.1	18	78.3	0.018
Yes	20	9.9	5	21.7	
Renal Disease					
No	193	95.5	20	87.0	0.011
Yes	9	4.5	3	13.0	
Obesity					
No	160	79.2	15	65.2	0.062 (NS)
Yes	42	20.8	8	34.8	

DISCUSSION

This school-based cross-sectional study enrolled 225 children aged 6–12 years from government and private schools in Bhopal to assess the prevalence and predictive factors of Elevated Blood Pressure and hypertension. Elevated Blood Pressure was identified in 23 children (10.22%). Significant associations were found with age, obesity, socioeconomic status, school type, lifestyle factors, and family history of hypertension, diabetes, cardiovascular disease, and renal disease. Renal abnormalities were detected in 3 hypertensive children.

The overall prevalence of Elevated Blood Pressure in the present study is comparable to the pooled prevalence of 7.6% reported by Daniel RA et al. in a systematic review of Indian studies [13]. Vijay Kiran and Harsha reported a slightly higher prevalence, whereas Naha et al. observed lower rates than in the present study [14,15]. These differences may be attributed to variations in study population, age distribution, obesity prevalence, and regional lifestyle and dietary practices. Similar findings have also been observed by the studies of Gunagi et al. and Patel et al. [16,17].

The significant association between obesity and raised blood pressure in our study is consistent with previous reports by James et al. and Vasudevan et al., supporting the role of excess adiposity in the development of childhood hypertension [18,19]. Higher prevalence of hypertension among children from upper socioeconomic groups and private schools, along with significant associations with reduced sleep, increased screen time, unhealthy dietary habits, lower physical activity, and positive family history, agrees with earlier studies emphasizing the contribution of genetic and modifiable lifestyle factors to pediatric hypertension [7,9,10,14–16,20,21]. The finding of renal abnormalities in 42.86% of hypertensive children further supports the established importance of renal parenchymal and renovascular diseases as secondary causes of hypertension in children [22].

Since the present study results are based on children from a single city and use a cross-sectional design, they limit long-term inference and generalizability. Lifestyle information was obtained using questionnaires, introducing the possibility of recall bias, and renal imaging was performed only in hypertensive children. Future multicentre longitudinal studies with larger sample sizes, objective assessment of lifestyle factors, and comprehensive cardiovascular and renal evaluation are recommended to better understand the determinants of childhood hypertension and strengthen school-based screening strategies.

CONCLUSION

According to the present study results, a notable proportion of school-going children aged 6–12 years in Bhopal had elevated blood pressure, which was significantly associated with obesity, adverse lifestyle behaviors, higher socioeconomic status, and positive family history. Routine

school-based blood pressure screening and early lifestyle interventions are recommended to reduce future cardiovascular risk.

REFERENCES

1. Williams B. 2018 ESC/ESH guidelines for the management of arterial hypertension. Eur Heart J. 2018;39(33):3021-3104.
2. Zhou B, Perel P, Mensah GA, Ezzati M. Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension. Nat Rev Cardiol. 2021; 18:785–802.
3. Hall ME, Hall JE, Whelton PK. Epidemiology, Pathophysiology, and Treatment of Hypertension. In: Fuster and Hurst's The Heart, 15e. New York: McGraw-Hill Education; 2022.
4. Chadha SL, Tandon R, Shekhawat S, Gopinath N. An epidemiological study of blood pressure among schoolchildren (5–14 years) in Delhi. Indian Heart J. 1999;51(2):178–182.
5. Kumar P, Kumar D, Ranjan A, Singh CM, Pandey S, Agarwal N. Prevalence of Hypertension and its Risk Factors Among School Going Adolescents of Patna, India. J Clin Diagn Res. 2017;11(1):SC01–4.
6. Sinha R, Saha A, Samuels J. American Academy of Pediatrics Clinical Practice Guidelines for Screening and Management of High Blood Pressure in Children and Adolescents: What is New? Indian Pediatr. 2019;56(4):317–321.
7. Verma M, Chhatwal J, George SM. Obesity and hypertension in children. Indian Pediatr. 1994;31(9):1065–1069.
8. Hale L, Guan S. Screen time and sleep among school-aged children and adolescents: a systematic literature review. Sleep Med Rev. 2015; 21:50–58.
9. Khoury M, Khoury P, Bazzano L, Burns TL, Daniels S, Dwyer T, et al. Prevalence Implications of the 2017 American Academy of Pediatrics Hypertension Guideline and Associations with Adult Hypertension. J Pediatr. 2022; 241:22-28.e4.
10. Wani RT. Socioeconomic status scales-modified Kuppuswamy and Udai Pareekh's scale updated for 2019. J Family Med Prim Care. 2019;8(6):1846-1849.
11. Daniel RA, Haldar P, Prasad M, et al. Prevalence of hypertension among adolescents (10–19 years) in India: A systematic review and meta-analysis of cross-sectional studies. PLoS One. 2020;15(10):e0239929.
12. Nika T, Stabouli S, Kollios K, et al. Obesity and season as determinants of high blood pressure in a school-based screening study. J Hum Hypertens. 2019;33(4):277-285.
13. Falkner B, Gidding SS, Baker-Smith CM, et al. Pediatric Primary Hypertension: An Underrecognized Condition: A Scientific Statement from the American Heart Association. Hypertension. 2023;80(6): E101–11.
14. Kiran V, Harsha. Prevalence of Hypertension in School Children Aged 9–16 Years in Bagalkot. Eur J Cardiovasc Med. 2024;14(4):724–730.
15. Naha NK, John M, Cherian VJ. Hypertension and Elevated Blood Pressure in school children. Int J ContempPediatr. 2016;3(3):931–938.
16. Gunagi P, Harikanth DR, Mulsange K. Prevalence of hypertension and its risk factors among urban school children of Belagavi. Int J Community Med Public Health. 2023;10(11):4246–4252.
17. Patel A, Bharani A, Sharma M, et al. Prevalence of hypertension and Elevated Blood Pressure in schoolchildren from Central India. Ann Pediatr Cardiol. 2019;12:349.
18. James BC, Venkateswaran A, Premkumar B, et al. The Prevalence of Elevated Blood Pressure and Its Association With Obesity in Children Aged 6–13 Years in Rural India: A Cross-Sectional Study. Cureus. 2023;15(4):e37916.
19. Vasudevan A, Thomas T, Kurpad A, Sachdev HS. Prevalence of and Factors Associated With High Blood Pressure Among Adolescents in India. JAMA Netw Open. 2022;5(10):1–13.
20. Gouroumourty R, Kumar A, Bhaskar S, et al. Prevalence of elevated blood pressure and hypertension based on repeat measurements among school-going adolescents in Central India. BMC Pediatr. 2025;25(1):716.
21. George B, Bhaskaran D, Leela LM, et al. Prevalence and Determinants of Hypertension among Adolescents: A Cross-Sectional Study in South Kerala. J Med Sci Health. 2025;11(3):244–250.
22. Chrysaidou K, Chainoglou A, Karava V, et al. Secondary Hypertension in Children and Adolescents: Novel Insights. CurrHypertens Rev. 2020;16(1):37–44.

How to cite this article: Patle M, Neema K, Lakhwani S, Tiwari A, Patel U. Prevalence and Predictive Factors of Elevated Blood Pressure and Hypertension in School-Going Children Aged 6 to 12 Years: A School-Based Cross-Sectional Study. Indian J Child Health. 2026; 13(7):95-101.

Funding: None; Conflicts of Interest: None Stated.