

# A Cross-Sectional Study on Correlates of High Blood Pressure among School-Going Children in an Urban Area

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## Abstract

**Context:** School-going children are documenting the increasing incidence of high blood pressure (BP). Compared to adults, the prevalence of hypertension (HT) is low among children, but high BP among them can lead to HT in their adult life. **Aim:** The aim of was to study the risk factors and correlates of high BP among school-going children. **Materials and Methods:** A cross-sectional study was carried out for 1½ years among 892 randomly selected school children of 6<sup>th</sup>–10<sup>th</sup> class. Measurements such as height, weight, and BP were recorded and classified as per the standard guidelines for given age and sex. **Statistical Analysis:** Correlation and linear regression analysis were done for continuous variables. For dichotomous variables, mean and standard deviation were calculated and *t*-test was used in this study. **Results:** Higher age group, being male, and obesity were found to be significantly associated with elevated systolic BP (SBP) and elevated diastolic BP (DBP). Family history of diabetes and HT was significantly associated with elevated DBP. On linear regression analysis, the studied factors explained 30% variation in SBP and only 12% variation in DBP. Weight and body mass index explained the maximum variation in both SBP and DBP. **Conclusion:** Overweight or obesity, being male, family history of HT, and increasing age were important risk factors of elevated BP.

**Keywords:** Hypertension, morbidity, obesity

## INTRODUCTION

School-going children are documenting the increasing incidence of high blood pressure (BP) as a result of sedentary lifestyle. They are vulnerable to the development of a matrix of noncommunicable diseases in their adult life.<sup>[1]</sup>

It has been estimated that the prevalence of hypertension (HT) among youth varies from 1 to 5%.<sup>[2]</sup> High BP among early life predicts that the individual will continue to have high BP in his/her adult life and may predispose to HT and other diseases. Obesity has been predicted as the number one modifiable risk factor of high BP among children.<sup>[3]</sup>

Apart from obesity, a shift in dietary habits from traditional, high levels of stress, a positive family history, and reduced overall physical activity are risk factors of HT. Compared to adults, the prevalence of HT is low among children, but HT tends to develop in the first 20 years of life. Tracking of BP is useful in predicting future HT. HT is itself a risk factor for stroke and ischemic heart disease.<sup>[4]</sup>

It is recommended that school-going children be regularly screened for elevated BP to identify potential future hypertensive adults. Early detection will lead to timely intervention by the investigator, school teachers, and parents to modify lifestyle of all school-going children and help prevent future pandemics. Hence, the present study was planned to study the correlates of high BP among school-going children.

## MATERIALS AND METHODS

Institution-based cross-sectional study was carried out for 1½ years among 892 randomly selected school children of 6<sup>th</sup>–10<sup>th</sup> class.

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After obtaining Institutional Ethics Committee approval, permission from District Education Officer was taken.

A study by Sharma *et al.*<sup>[5]</sup> reported that prevalence of elevated BP (HT and pre-HT) among school children aged 11–17 years was 18.2%. Based on this report, taking prevalence of high BP as 18% with 95% confidence interval and 15% of allowable error, the sample size came out to be 810. It was rounded to 900.

With this backdrop in mind, to reach out to 900 school children, we decided to study 18 schools. From each school, 50 children were selected randomly. Each school was having classes 6<sup>th</sup>–10<sup>th</sup>. That is, there were a total of five classes. Hence, from each class, 10 students were selected using systematic random sampling. There were a total of 87 schools having 6<sup>th</sup>–10<sup>th</sup> class in the study area and total numbers of students were 29,845. Out of these 87 schools, 18 schools were selected by simple random sampling having 5835 children. Permission from each selected school was taken from the respective principal. From each class of each school, a list of students was prepared and ten students were selected using systematic random sampling.

Eighty-seven schools are having 6<sup>th</sup>–10<sup>th</sup> class in the study area. Total numbers of students were 29,845.

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Eighteen schools were selected by simple random sampling having 5835 children.

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From each school, 50 children were selected randomly, thus including 900 children in the study.

School records were taken as the basis for verifying the age of the children. Parents of the children were interrogated to confirm the family history of diabetes, obesity, and HT. Anthropometric measurements were recorded and classified as per standard protocol and guidelines.

BP was measured in all children using standard sphygmomanometer. Children were asked to sit on a chair comfortably, relaxed with an arm stretched on the table and back supported. Pediatric bladder cuff (measuring four inches) was used to measure BP in younger children (bladder cuff which covers 40% of the mid-arm circumference and length long enough to encircle 80% of the arm), whereas adult cuff was used for older children, that is, children of 9<sup>th</sup> and 10<sup>th</sup> class (if ideal cuff is not available, use of a larger cuff is recommended to avoid spuriously high readings).<sup>[6]</sup> The bladder was inflated gradually 30 mmHg above the level at which radial pulse ceased. Then using the bell of the stethoscope over cubital fossa, gradually deflate the cuff and appearance of sound (Korotkoff phase I) was taken as systolic BP (SBP) and disappearance of sound was considered as diastolic BP (DBP). A total of three readings were taken in the study. The lowest reading was considered.<sup>[6,7]</sup>

### Statistical analysis

The data were entered in Microsoft Excel Worksheet. For continuous variables, the correlation was tested using Pearson

correlation coefficient. Then, the variables were subjected to linear regression analysis and *F* ratio was calculated. For dichotomous variables, mean, standard deviation, and Student's *t*-test were used. A *P* value of <0.05 was considered as statistically significant.

## RESULTS

Table 1 shows an association between risk factors and elevated SBP and elevated DBP. It was found that SBP among older children of age 14–17 years, among overweight and obese children, and among males was significantly higher (*P* < 0.05). Other factors such as family history of HT, diabetes, and obesity were not associated with elevated SBP. The significantly associated factors (*P* < 0.05) with elevated DBP were higher age group, being male, family history of HT as well as diabetes, and being overweight and obese. Only family history of obesity was not found to be associated with elevated DBP among children.

Table 2 shows the variables explaining variation in SBP and DBP. Highest variation in SBP was explained by weight (9%) followed by waist circumference (7%) and height (6%). Age explained only 1% of the variation in SBP, while body mass index (BMI) explained 5% variation. All these variations were statistically significant. All these factors together explained 30% of the variation in SBP and the remaining 70% remained unexplained. As against 30% variation explained by these factors in SBP, they could explain only 12% of the variation in DBP. Again weight explained the highest variation (4%) followed by 2% each by height, BMI, waist circumference, and hip circumference. Age and waist–hip ratio (WHR) could not explain variation in DBP.

## DISCUSSION

Institution-based cross-sectional study was carried out for 1½ years among 892 randomly selected school children of 6<sup>th</sup>–10<sup>th</sup> class.

Here, in the present study, we attempted to study and identify the factors that lead to high BP among this studied age group, that is, school-going children belonging to 6<sup>th</sup>–10<sup>th</sup> class.

We found that SBP and DBP were significantly more among elderly children compared to younger children but not significantly correlated and explained only 1% variation in SBP and less than that in DBP. Anand and Tandon<sup>[8]</sup> observed that BP increased with increasing age. Similarly, Taksande *et al.*<sup>[4]</sup> and Sayeemuddin *et al.*<sup>[9]</sup> noted that SBP and DBP increased with increasing age. Increase of BP with increasing age is a natural and well-known phenomenon. Hence, almost all the studies including the present study found that increased age is associated with the higher BP. We could not find a significant correlation between age and high BP, and this may be due to the presence of confounders in the correlation analysis.

Male children had significantly higher SBP and DBP in the present study. However, Verma *et al.*,<sup>[10]</sup> Anand and

**Table 1: Association between risk factors and elevated systolic blood pressure and elevated diastolic blood pressure**

Risk factor	Subgroup	Total number	SBP			DBP		
			Mean±2SD	t	P	Mean±2SD	t	P
Age (years)	10-13	527	87.21±11.79	3.3125	0.0010*	56.03±10.43	2.0364	0.0420*
	14-17	365	90.00±13.16			57.54±11.52		
Sex	Male	448	89.93±12.49	3.8477	0.0001*	58.89±10.68	5.0053	0.0001*
	Female	444	86.75±12.19			55.27±10.92		
Family history of hypertension	Yes	136	89.82±11.86	1.4952	0.1352	58.39±11.15	2.0564	0.0400*
	No	756	88.09±12.52			56.29±10.93		
Family history of diabetes	Yes	83	89.27±12.54	0.7049	0.4810	59.40±10.57	2.3906	0.0170*
	No	809	88.26±12.42			56.41±10.88		
Family history of obesity	Yes	108	89.55±14.73	1.0661	0.2867	57.91±12.74	1.2458	0.2132
	No	784	88.19±12.08			56.52±10.59		
Overweight + obesity	Yes	131	94.34±12.04	2.27	0.02356*	60.61±10.42	3.95	0.0007571*
	No	761	89.65±19.10			50.66±19.93		

\*Significant at 0.05 level. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation

**Table 2: Variables explaining variation in systolic blood pressure and diastolic blood pressure**

Correlates	SBP			DBP		
	R <sup>2</sup>	F	F significance	R <sup>2</sup>	F	F significance
Age	0.0129	12.67	0.0003*	0.00175	2.56	0.109
Height	0.0618	59.699	0.0000*	0.0222	21.28	0.0000*
Weight	0.0962	95.81	0.0000*	0.0441	42.16	0.0000*
BMI	0.0575	55.39	0.0000*	0.02799	26.65	0.0000*
Waist circumference	0.0753	73.62	0.0000*	0.0273	26.029	0.0000*
Hip circumference	0.0206	89.81	0.0000*	0.0221	21.22	0.0000*
WHR	-0.0011	0.023	0.877	0.00078	1.69	0.193
Total variation explained by all factors together (%)		30			12	

\*Significant at 0.05 level. BMI: Body mass index, WHR: Waist-hip ratio, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Tandon<sup>[8]</sup> and Rosaneli *et al.*<sup>[11]</sup> found that high BP was not associated/correlated with sex. This particular contrast of present study finding and the finding with the other studies may be attributed to geographical variations which are generally associated with gender preferences such as giving more preference to males and many other factors.

We observed that positive family history of HT as well as diabetes was significantly associated with DBP but not with SBP. Sayeemuddin *et al.*<sup>[9]</sup> and Anand and Tandon<sup>[8]</sup> observed that family history of HT was a significant risk factor for elevated BP. This unanimous observation across the studies helps to identify at-risk individuals and helps to design a high-risk approach. Thus, children of diabetic and hypertensive parents can be identified by schools, and these should be given more attention to prevent/delay the occurrence of noncommunicable diseases among them using proper interventions.

We carried out the correlation between variables and SBP and DBP separately. We found that only weight, BMI, and hip circumference were significantly correlated with SBP, whereas height, weight, BMI, and waist and hip circumference were significantly correlated with DBP. Age and WHR were not found to have a correlation with SBP as well as with DBP.

On linear regression analysis, we found that highest variation in SBP was explained by weight (9%) followed by waist circumference (7%) and height (6%). Age explained only 1% of the variation in SBP, while BMI explained 5% variation. All these variations were statistically significant. All these factors together explained 30% of the variation in SBP and the remaining 70% remained unexplained. As against 30% variation explained by these factors in SBP, they could explain only 12% of the variation in DBP. Again weight explained the highest variation (4%) followed by 2% each by height, BMI, waist circumference, and hip circumference. Age and WHR could not explain any variation in DBP.

Taksande *et al.*<sup>[14]</sup> also found a highly significant correlation of height, weight, and BMI with SBP as well as with DBP. Kaur *et al.*<sup>[12]</sup> also showed a significant positive correlation between BMI and SBP and waist circumference and SBP as well as DBP. Rosaneli *et al.*<sup>[11]</sup> found that SBP and DBP were correlated well with BMI, waist circumference, and hip circumference but not with WHR. Sukhonthachit *et al.*<sup>[13]</sup> also reported that children with HT had higher weight, height, waist circumference, and BMI. Mohan *et al.*<sup>[14]</sup> found a significant association between BMI and high BP. Similarly, Raj *et al.*<sup>[15]</sup> also reported a significant association between obesity and HT.

Freedman *et al.*<sup>[16]</sup> carried out tracking of BP among 11,478 children and adolescents over a period of 20 years and observed that SBP and DBP changed to a very small extent. BMI was found to be significantly associated with SBP and DBP changes. SBP did not change for the race-gender group but DBP decreased by 2 mmHg. The present study also observed similar findings.

Wang *et al.*<sup>[17]</sup> studied 5155 students aged 6–15 years. They noted that BMI, age, and weight were positively correlated with SBP and DBP. These findings are similar to the present study findings.

Dong *et al.*<sup>[18]</sup> measured BP and BMI of 391,982 children of 7–17 years from 2005 to 2010. They noted that SBP and DBP increased over 2005–2010, both for boys and for girls. It was found to be correlated well with BMI.

Thus, as we observed and in agreement with other studies, correlation and regression analysis proved that weight, BMI, and waist circumference were strongly associated with high BP (both SBP and DBP) among school children. Thus, school teachers should be trained to identify these children with higher weight, BMI, and waist circumference as well as those children with family history of diabetes and HT. The school teachers can inculcate healthy lifestyle among these children to prevent the occurrence of noncommunicable diseases among these children in their future.

## CONCLUSION

Out of the variables studied such as age, height, weight, BMI, waist circumference, hip circumference, and WHR, only weight, BMI, and hip circumference were correlated with SBP but on regression, they were found to explain 30% of the variation in SBP altogether. On the contrary, for DBP, compared to SBP, more factors were correlated but altogether they could explain only 12% of the variation in DBP. Thus, SBP may not be related to the variables studied but gets affected by them. Moreover, DBP shows good correlation with these variables but will not vary on variation of these factors. As weight, waist circumference, and BMI were found to be significantly explaining a lot of variation in SBP as well as DBP; the prevention program should target regular physical activity and monitoring of weight among school children.

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## Conflicts of interest

There are no conflicts of interest.

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