

Anthropometric correlates of blood pressure among school children in Nagpur city, central India: A cross-sectional study

Abstract

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Context: On the basis of emerging evidence, it is now apparent that primary hypertension is detectable in the young and that it occurs commonly. The long-term health risks for hypertensive children and adolescents can be substantial. Early diagnosis of hypertension (HT) is an important strategy in its control. Previous studies have documented that hypertension may begin in adolescence, perhaps even in childhood. **Aims:** To determine the prevalence of hypertension and its correlation with anthropometric variables like height, weight and body mass index (BMI) among school-going children in Nagpur city, Central India. **Settings and Design:** Cross-sectional study done in one randomly selected school. **Materials and Methods:** School-going children aged between 12 and 16 years were included in the study. The weight and height were measured using a standard procedure. Blood pressure measurements were taken by a mercury sphygmomanometer. Hypertension was diagnosed if blood pressure was more than 95th percentile for the age and height. The distributions of blood pressure by anthropometric characteristics were studied. **Statistical Analysis Used:** Mean, standard deviation, correlation coefficient and χ^2 test were used for statistical analysis. **Results:** The overall prevalence of hypertension was found to be 11.77%. Blood pressure of both genders appears to have positive correlation with anthropometric characteristics. **Conclusions:** Increase in anthropometric measurements like height, weight and BMI were found to be positively correlated with hypertension among school children in the present study.

Key words: Anthropometric measurements, hypertension, obesity, school children

INTRODUCTION

The prevalence of hypertension in children and adolescents seems to be increasing.^[1] This rise is partially because of the increasing prevalence of obesity among children and adolescents, as well as a growing awareness of this disease. There is evidence that hypertension in children and adolescents can lead to adult hypertension.^[2,3] Presence of hypertension in children and adolescents may contribute to the early development of coronary artery disease. Previous reports have shown that early development of atherosclerosis does exist in children and adolescents and may be associated with childhood hypertension.^[4,5]

Appropriate early-stage diagnosis and interventions of hypertension in children and adolescents are important for reducing the risk of hypertension-related disorders in adults.

Keeping in view the seriousness of problem on one hand and lack of data about the prevalence of hypertension among school children in Nagpur on another, the present study was undertaken among the school children in Nagpur, to find out prevalence of hypertension and the relationship of hypertension with anthropometric variables like height, weight and body mass index (BMI).

MATERIALS AND METHODS

Study design and setting

A cross-sectional study among 450 school children was carried out in Nagpur city, from November 2011 to January 2012 in urban area under "Urban Health Training Centre, Gandhinagar, Indira

Gandhi Govt. Medical College, Nagpur, Maharashtra, India. The study population comprised students aged 12 to 16 years living in the study area. Out of 13 schools, one school was selected by simple random sampling method. Students from 8th to 10th standard were included in the study. Permission from school authority was sought before the start of the study. Institutional ethical committee's clearance was sought before the start of the study.

Data collection

All students present in the classes at the time of interview were included in the study. In all, 450 students were interviewed. Every student was interviewed personally by an investigator using a self-administered, pretested questionnaire.

General information regarding age, sex, religion, diet and addiction was collected using a pretested proforma. Anthropometric measurements such as weight was taken by a standardized weighing machine with accuracy up to 0.1 kg while height was measured using a standard stadiometer with accuracy up to 0.5 cm. Blood pressure measurements were taken by a standard mercury sphygmomanometer. Three blood pressure measurements were taken at an interval of 5 minutes and the average of the three readings was used in the analysis.

Hypertension was diagnosed if blood pressure was more than 95th percentile for the age and height.^[6,7] BMI was calculated and classified according to WHO^[8] into five categories based on z-scores. The cut-off values of z-score for overweight are BMI >+ 1SD (equivalent to BMI 25 kg/m² at 19 years), obesity > +2SD (equivalent to BMI 30 kg/m² at 19 years), thinness <-2SD, severe thinness <-3SD and normal within -1SD to +1SD.

The distribution of blood pressure by anthropometric characteristics like height, weight and BMI were studied.

Data analysis

Data were entered in Microsoft Excel 2007 and analyzed with Graphpad Prism 5. Mean and standard deviation were calculated for categorical data and χ^2 test was used as a test of significance. Pearson's Correlation coefficient was calculated to assess correlation between hypertension and height, weight and BMI of school children.

RESULTS

Out of 450 school children, there were 229 boys (50.89%) and 221 girls (49.11%). Total prevalence of hypertension was found to be 11.77% (53/450). The prevalence of hypertension among boys and girls were found to be almost same i.e., 11.79% (27/229) and 11.76% (26/221), respectively [Table 1].

The highest prevalence of hypertension was observed in 12 years of age in both sexes (22.22% in boys and 30% in girls) followed by 16 years (11.32% in boys and 25% in girls).

Mean age (\pm SD) of the school children was 14.11 \pm 1.25 years. Even with the short span of five years in the study (12-16 years) the mean blood pressure increased significantly with age [$r = 0.19$ for systolic blood pressure (SBP) and $r = 0.07$ for diastolic blood pressure (DBP)] as evident from [Table 2]. The mean SBP of both sexes was 110.39 mm Hg at the age of 12 years and 116.76 mm Hg at the age of 16 years, an increase of 6.37 mm Hg. Similarly, the increase of DBP was observed as 4.43 mm Hg for the same group. So, the age effect was found to be more for SBP in the present study.

The result revealed that SBP and DBP of both sexes have a positive correlation ($P < 0.01$) with height; correlation of SBP with height was found to be 0.19 for boys and 0.21 for girls, and that of DBP were 0.21 and 0.26 for boys and girls, respectively [Table 3].

Table 1: Prevalence of hypertension in adolescents

Age (yrs)	Boys n = 229		Girls n = 221		Total n = 450	
	No.	HTN (%)	No.	HTN (%)	No.	HTN (%)
12	27	6 (22.22)	30	9 (30.00)	57	15 (26.31)
13	30	3 (10.00)	57	4 (7.01)	87	7 (8.04)
14	51	5 (9.80)	77	4 (5.19)	128	9 (7.03)
15	68	7 (10.29)	37	4 (10.81)	105	11 (10.47)
16	53	6 (11.32)	20	5 (25.00)	73	11 (15.06)
Total	229 (50.89)	27 (11.79)	221 (49.11)	26 (11.76)	450 (100)	53 (11.77)

Table 2: Frequency distribution of SBP & DBP for adolescents in different age

Age in Years	Boys			Girls			Overall		
	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)
12	27	110.54 (\pm 11.06)	72.60 (\pm 8.62)	30	110.24 (\pm 10.91)	72.60 (\pm 8.62)	57	110.39 (\pm 10.90)	72.60 (\pm 8.68)
13	30	114.77 (\pm 11.44)	74.21 (\pm 9.23)	57	114.31 (\pm 11.27)	74.60 (\pm 9.02)	87	114.54 (\pm 11.25)	74.40 (\pm 9.01)
14	51	115.16 (\pm 11.16)	76.62 (\pm 8.93)	77	115.29 (\pm 11.03)	75.70 (\pm 8.93)	128	115.22 (\pm 10.94)	76.16 (\pm 8.80)
15	68	115.26 (\pm 11.01)	76.87 (\pm 8.92)	37	115.68 (\pm 11.11)	75.86 (\pm 9.09)	105	115.47 (\pm 11.01)	76.36 (\pm 8.92)
16	53	116.99 (\pm 11.36)	77.96 (\pm 9.00)	20	116.54 (\pm 11.46)	76.11 (\pm 9.15)	73	116.76 (\pm 11.36)	77.03 (\pm 9.00)

In both sexes, a rise is observed in mean SBP and DBP with increase in mean weight [Table 4]. In the present study, correlation coefficient of SBP with weight was 0.35 and 0.36 and that of DBP was 0.30 and 0.33 in boys and girls, respectively.

In our study, 32 (7.11%) children were overweight and obese and 357 (79.33%) were having normal BMI, while the remaining 61 (13.56%) were underweight [Table 5]. Among these 32 children, 18 (56.25%) were hypertensive; of the remaining 418 children, 35 (8.37%) were hypertensive [Table 6]. When this association of higher BMI with hypertension was studied, it was found to be statistically significant ($P = 0.0000$). Also, the result revealed that SBP and DBP of both sexes have a positive correlation ($P < 0.01$) with BMI; correlation of SBP with BMI was found to be 0.39 for boys and 0.21 for girls, and that of DBP with BMI was 0.20 and 0.32 in boys and girls, respectively.

DISCUSSION

In our study, we found 11.77% prevalence of hypertension among adolescents. Durrani *et al.*^[9] reported 9.4% prevalence of hypertension in the same age group i.e., 12-16 years in Aligarh. Also similar prevalence (11.7%) was reported by Chadha *et al.*^[10] in

Delhi. Other studies done in different parts of India reported a vast range in the prevalence of hypertension in children and adolescents showing as high as 21.5% to as low as 3.67%.^[11,12] Other researchers across India also found varied prevalence of hypertension among adolescents. Taksande *et al.*^[13] reported 5.75% in rural Wardha, Khan *et al.*^[14] reported 9.78% prevalence in Ahmedabad, Mane *et al.*^[15] found 4% prevalence in Western India. In New Delhi, 7.84% prevalence was reported by Singh *et al.*^[16] Also, Borade *et al.*^[17] reported 10.91% prevalence of hypertension in Pune among adolescents. This varied prevalence may be due to different criteria used for diagnosis of hypertension and varied socio-cultural and socioeconomic environment of the adolescents residing in different parts of India.

We found slightly lower prevalence of hypertension in girls (11.76%) than in boys (11.79%). This difference in prevalence of hypertension was not found to be statistically significant ($P > 0.05$). Similar results were reported by Prabhjot *et al.*^[18] in Amritsar, Punjab, with 8.3% prevalence of hypertension in boys and 6.52% prevalence in girls. But Durrani *et al.*^[9] found lower prevalence of hypertension in boys (9.36%) than in girls (9.4%). Also, there is varied prevalence of hypertension in different age groups. The difference in patterns of blood pressure between males and females and varied prevalence

Table 3: Frequency distribution of SBP and DBP for adolescents in different height ranges

Range height	Boys			Girls			Overall		
	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)
1.31-1.40	25	115.08 (\pm 11.01)	74.68 (\pm 8.85)	33	115.38 (\pm 11.06)	74.97 (\pm 9.02)	58	115.01 (\pm 11.00)	74.71 (\pm 8.78)
1.41-1.50	49	116.06 (\pm 11.35)	75.07 (\pm 8.97)	87	116.20 (\pm 11.44)	75.06 (\pm 9.09)	136	115.74 (\pm 11.22)	75.00 (\pm 8.97)
1.51-1.60	59	116.05 (\pm 11.36)	75.01 (\pm 8.97)	82	116.05 (\pm 11.39)	75.07 (\pm 8.96)	141	116.05 (\pm 11.36)	75.01 (\pm 8.97)
1.61-1.70	63	116.05 (\pm 11.40)	75.03 (\pm 9.00)	16	116.26 (\pm 11.45)	75.08 (\pm 9.04)	79	116.05 (\pm 11.40)	75.03 (\pm 9.00)
1.71-1.80	33	116.06 (\pm 11.43)	74.92 (\pm 9.06)	03	116.33 (\pm 11.49)	74.66 (\pm 9.31)	36	116.06 (\pm 11.43)	74.92 (\pm 9.06)

Pearson correlation coefficient (r), Height (m) overall = 0.19 (SBP) and 0.24 (DBP), r (Boys) = 0.19 (SBP) and 0.24 (DBP), r (Girls) = 0.21 (SBP) and 0.26 (DBP)

Table 4: Frequency distribution of SBP and DBP for adolescents in different weight ranges

Range weight (kg)	Boys			Girls			Overall		
	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)	No.	Mean SBP (\pm SD)	Mean DBP (\pm SD)
21-30	24	116.02 (\pm 11.10)	74.54 (\pm 8.81)	9	115.81 (\pm 11.00)	74.31 (\pm 8.85)	33	115.81 (\pm 11.00)	74.31 (\pm 8.85)
31-40	64	115.89 (\pm 11.31)	74.99 (\pm 8.96)	82	115.29 (\pm 11.05)	74.88 (\pm 8.98)	146	115.00 (\pm 11.31)	74.97 (\pm 8.96)
41-50	92	116.00 (\pm 11.37)	74.97 (\pm 9.00)	107	116.05 (\pm 11.39)	75.07 (\pm 8.96)	199	116.00 (\pm 11.37)	74.97 (\pm 9.00)
51-60	38	116.14 (\pm 11.44)	74.99 (\pm 9.05)	19	116.26 (\pm 11.45)	75.08 (\pm 9.04)	57	116.14 (\pm 11.44)	74.99 (\pm 9.07)
61-70	11	116.05 (\pm 11.41)	74.99 (\pm 9.09)	04	115.34 (\pm 10.95)	74.88 (\pm 9.17)	15	116.05 (\pm 11.41)	74.99 (\pm 9.09)

Pearson correlation coefficient (r), Weight (kg) overall = 0.35 (SBP) and 0.37 (DBP), r (Boys) = 0.35 (SBP) and 0.30 (DBP), r (Girls) = 0.36 (SBP) and 0.33 (DBP)

Table 5: Distribution of students according to their BMI category and hypertension

BMI category (kg/m ²) (Z-scores)	Boys			Girls			Overall		
	No	Mean SBP (+SD)	Mean DBP (+SD)	No	Mean SBP (+SD)	Mean DBP (+SD)	No	Mean SBP (+SD)	Mean DBP (+SD)
Normal (-1SD to +1SD)	162	116.04 (\pm 11.36)	74.97 (\pm 9.01)	195	116.07 (\pm 11.38)	75.07 (\pm 8.95)	357	116.05 (\pm 11.35)	74.99 (\pm 9.00)
Overweight (>+1SD)	13	115.85 (\pm 11.29)	75.01 (\pm 8.95)	17	116.17 (\pm 11.32)	75.00 (\pm 8.95)	30	115.85 (\pm 11.29)	75.01 (\pm 8.95)
Obese (>+2SD)	02	115.23 (\pm 11.07)	74.71 (\pm 8.89)	00	—	—	02	115.23 (\pm 11.07)	74.71 (\pm 8.89)
Thinness (<-2SD)	35	116.12 (\pm 11.43)	74.93 (\pm 9.09)	09	115.57 (\pm 11.24)	74.67 (\pm 9.12)	44	116.12 (\pm 11.43)	74.93 (\pm 9.09)
Severe Thinness (<-3SD)	17	115.69 (\pm 11.2)	74.96 (\pm 8.96)	00	—	—	17	115.69 (\pm 11.2)	74.96 (\pm 8.96)

Pearson correlation coefficient (r) BMI (kg/m²) overall = 0.28 (SBP) and 0.27 (DBP), r (Boys) = 0.39 (SBP) and 0.20 (DBP), r (Girls) = 0.21 (SBP) and 0.32 (DBP)

Table 6: Association of hypertension to higher BMI category

BMI category	Hypertension		Total
	Present	Absent	
Overweight + Obese	18 (56.25)	14 (43.75)	32 (7.11)
Normal + Thinness + Severe Thinness	35 (8.37)	383 (91.63)	418 (92.89)
Total	53 (11.77)	397 (88.23)	450 (100)

P value = 0.0000, $\chi^2 = 63.88$, $df = 1$ VHS

of hypertension in different age groups are probably related to certain biological, psychosocial factors and puberty timings.^[13]

In our study, we found the positive correlation between hypertension and the anthropometric variables like height ($P < 0.0001$), weight ($P < 0.0001$) and BMI ($P < 0.0001$). Overall coefficient of correlation of height with blood pressure was 0.19 for SBP and 0.24 for DBP. SBP and DBP of both genders established the positive correlation ($P < 0.0001$) with height, which is in accordance with the findings of Durrani *et al.*^[9] Gupta *et al.*^[19] and Saha *et al.*^[20]

The correlation coefficient of SBP and DBP of both genders also showed a positive correlation with weight [SBP $r = 0.35$ (boys) and 0.36 (girls) and DBP $r = 0.30$ (boys) and 0.33 (girls)], which agreed with the finding of Durrani *et al.*^[9] [SBP $r = 0.47$ (boys) and 0.50 (girls) and DBP $r = 0.46$ (boys) and 0.42 (girls)] and Gupta *et al.*^[19] [SBP $r = 0.55$ (boys) and 0.58 (girls) and DBP $r = 0.61$ (boys) and 0.52 (girls)].

Similarly other studies done in different parts of India also showed a positive correlation of SBP and DBP with height and weight of adolescents. Taksande *et al.*^[13] showed positive correlation of height with SBP ($r = 0.39$) and with DBP ($r = 0.31$). They also showed positive correlation between weight of adolescents and SBP ($r = 0.39$) and with DBP ($r = 0.28$). Saha *et al.*^[20] also reported significant positive correlation of height [SBP $r = 0.62$ (boys) and 0.54 (girls) and DBP $r = 0.52$ (boys and girls)] and weight [SBP $r = 0.77$ (boys) and 0.76 (girls) and DBP $r = 0.76$ (boys) and 0.63 (girls)] with SBP and DBP of both genders.

Overall, the mean BMI of the study participants was found to be 18.11 ± 2.68 , while mean BMI of boys was 17.38 ± 2.52 and that of girls was 18.87 ± 2.64 . Similar results were reported by Kapil *et al.*^[21] who found that mean BMI for boys was 20.76 kg/m^2 and for girls it was 21.02 kg/m^2 . Mane *et al.*^[15] also reported a BMI of 19.11 kg/m^2 for boys and 18.92 kg/m^2 for girls. Rahman *et al.*^[22] also reported a mean BMI of 18.5 ± 4.3 in a study done among school children (mean age 14 ± 1.3 years) in Karachi, Pakistan. These differences in BMI can be attributed to socioeconomic and environmental differences.

In the present study, we found 7.11% overweight and obese adolescents. Prevalence of hypertension among these was 56.25% (18/32) as compared to the prevalence in normal and other children i.e., 8.37% [Table 6]. And this difference in the prevalence was found to be statistically significant ($P = 0.0000$). Raj *et al.*^[23] in 2007 determined the relationship of obesity with blood pressure.

Systolic or diastolic incident hypertension was found in 17.34% of overweight children versus 10.1% of the remaining students. Desai *et al.*^[24] reported 5% prevalence of overweight adolescents in Surat city while Rahman *et al.*^[22] estimated 7% and 2% prevalence of overweight and obesity, respectively, which are similar findings to our study.

It is evident from this school-based epidemiological study that increase in BMI predisposes the adolescent individual to higher blood pressure and subsequently, hypertension. A statistical significance was found between overweight/obesity and hypertension in the present study. A similar finding was also reported elsewhere in India; Chakraborty *et al.*^[12] found 17.12% prevalence of overweight and 2.45% prevalence of obesity among adolescents of Kolkata city. They also found the statistically significant association between presence of hypertension and overweight and obesity ($P < 0.001$). Khan *et al.*^[14] reported 10.44% and 5.77% prevalence of overweight and obesity, respectively in adolescent school boys (12-19 years) in Ahmedabad city. Nanaware *et al.*^[25] showed significantly positive correlation between BMI and SBP ($r = 0.81$, $P < 0.001$) and with DBP ($r = 0.72$, $P < 0.01$) in the age group of 13-16 years.

Mane *et al.*^[15] also reported that the increasing BMI contributed to increase in SBP ($P = 0.000$) and DBP ($P = 0.000$) in their study. Shah *et al.*^[26] reported 8.94% prevalence of obesity and 20.9% prevalence of hypertension among adolescents of Surat city. They also found that the prevalence of hypertension adolescents was more in obese as compared to normal ($P = 0.0034$). Thus, our findings are consistent with the above studies.

CONCLUSION

Increase in anthropometric measurements like height, weight and BMI were found to be positively correlated with hypertension among school children in the present study.

Recommendation

Children must be screened to detect and check the presence of hypertension and influencing factor like overweight. High risk children who are overweight and obese should be given close follow-ups. Extended research is required to find out association of hypertension and various risk factors like diet, regular exercise and weight reduction. Appropriate health education need to be given at home and school so that these risk factors can be eliminated in early stages itself.

Limitations

This was a cross-sectional study mainly intended to get blood pressure distribution and its relation to anthropometric measurements among school children, so to obtain a more precise idea about trends of blood pressure some longitudinal studies may be required. Further similar studies can be done with a larger sample size in this region to get more accurate results of blood pressure for children and adolescents.

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