An Epidemiological Study of Blood Pressure and Its Relation with Anthropometric Measurements among Schoolboys of Burdwan Municipal Area, West Bengal

Kaushik Nag, Nabarun Karmakar, Indranil Saha, Samir Dasgupta, Bijay Prasad Mukhopadhyay, Md. Rafiul Islam Mondal

Department of Community Medicine, Tripura Medical College and Dr. BRAM Teaching Hospital, Agartala, Tripura, 1Department of Community Medicine, IQ City Medical College, Durgapur, 2Department of Community Medicine, North Bengal Medical College, Darjeeling, 3Deputy C.M.O.H-1, Office of the Chief Medical Officer of Health, Purba Bardhaman, 4Medical Officer, Krishnanagar Municipality Hospital, Krishnanagar, West Bengal, India.

Abstract

Background: High blood pressure (BP) is often an underdiagnosed problem, because of the asymptomatic nature in early phases of onset during adolescence. This increases the chances of developing complications later during adult life. Objective: The objective of this study was to find the relationship of BP with anthropometric measurements among school-going adolescent boys. Materials and Methods: It was a cross-sectional study conducted among 894 adolescent schoolboys aged 13 to 18 years from July 2013 to October 2014 in schools of Burdwan Municipal area, West Bengal. The required number of students from each school was determined by proportional probability sampling. Then, the required number of students from each school was selected by systematic random sampling technique. BP and anthropometric measurements such as weight, height, and waist circumference were done using standard guidelines. Results: The mean systolic and mean diastolic BP in the study participants was significantly higher with an increase in weight, height, waist circumference, and body mass index (BMI) ($P < 0.05$). BP was found to be positively correlated with different anthropometric measurements such as weight, height, waist circumference, and BMI, which were statistically significant. Conclusion: Early detection of high BP and application of lifestyle modification among adolescents will be helpful in reducing the burden of high BP in adult life.

Keywords: Adolescents, anthropometry, blood pressure, correlation, measurements, municipal area

Introduction

Hypertension is one of the most common public health problems globally among adults and often begins in the childhood and adolescent period. India is in the process of rapid economic development, and modernization with changing lifestyle factors has an increasing trend of hypertension, especially among urban population. Several studies in India have reported the prevalence of hypertension to be ranging between 0.46% and 15% among children and adolescents.

Many environmental and genetic factors play a great role in the causation of high blood pressure (BP) such as age, gender, body size, physical inactivity, diet, and stress levels but during adolescence, obesity, and metabolic syndrome, familial factors of hypertension remain the main influencing factor for developing hypertension later in adult life. High BP is often an underdiagnosed problem, because of the asymptomatic nature in early phases of onset during adolescence, and this increases the chances of developing complications during adulthood. The incorporation of BP measurement into routine pediatric examination has led to the discovery of significant number of children with asymptomatic hypertension. Children with higher BP tend to maintain those levels of BP in adulthood. The on-going rise in the prevalence of hypertension becomes a common problem in children and adolescents, which is considered to...
be accompanied with the epidemic of childhood overweight and obesity, as well as a growing awareness of this disease. Positive association of body mass index (BMI) and BP has also been reported among Asian populations. Studies have demonstrated that overweight and obesity has led to an increase in insulin resistance along with a concomitant elevation in systolic BP (SBP) and diastolic BP (DBP), dyslipidemia, diabetes, etc., in children.

There are few studies which showed that different patterns of BP were found in Indian children and adolescents, particularly in relation with anthropometric characteristics, but there is a dearth of the literature on BP profile among children and adolescent, particularly in this part of the country. With this backdrop, the present study was conducted among schoolboys of Class IX to XII to find the pattern of BP and its relationship with anthropometric measurements, if any in Burdwan Municipal area, West Bengal.

**Materials and Methods**

**Study type and design**

This was a school-based epidemiological study with a cross-sectional design conducted on adolescent boys from July 2013 to October 2014.

**Sample size and sampling**

Four boys' higher secondary (HS) schools were selected by simple random sampling out of 11 boys' HS schools of Burdwan Municipal area. Considering the prevalence of hypertension among adolescent boys as 9.78% in a study, the estimated sample size came as 975. The number of required sample from each of the four schools was selected by proportion probability sampling. The total number of boys of each school was listed (sampling frame) consecutively from Class IX to XII. Then, students were selected by systematic random sampling technique from each school till required sample students were achieved in each school. Finally, a total of 894 students (response rate: 91.7%) were included in the study from all four boys' HS schools. The study was approved by the Institutional Ethics Committee, and written consent was obtained from the students and the school authorities. All the boys studying in Class IX to XII were included in the study except those who were ill or absent at the time of interview and unwilling to participate.

**Method of data collection and operational definition**

A single observer took all the measurements after the equipment were standardized and validated before each school visit by adhering the standard procedure for measurement. BP was recorded by the auscultatory method in the sitting position, in a relaxed manner in a quiet room at the end of interview. Age-specific width of the cuff was applied midway between the olecranon and acromion processes, encircling about two-third of the upper arm for measuring BP. For each participant, three recordings were taken at an interval of 5 min and the average of these three readings was taken and it was considered to be the final reading. Those with SBP, DBP, or both having 95th percentile value or more than the predicted value for their respective age were considered to have systolic hypertension, diastolic hypertension, or overall hypertension, respectively. Weight (nearest 0.1 kg) was measured once and was obtained with participant wearing light clothing and without shoes. Height (nearest 0.1 cm) was measured once and was obtained with participant standing without shoes, with the head positioned so that the eye–ear plane was horizontal and the heels, buttocks, and shoulders touching a wall (against a vertical surface) and head forward. BMI was computed as weight in kg/height in m². The criteria taken for estimation of overweight and obesity among the study participants were ≥85th percentile and ≥95th percentile of body weight, respectively, from the WHO reference value. Waist circumference was measured with a nonstretchable tape by trained persons (exerting the same standard pressure on the tape) at the midpoint of the lowest rib cage and the iliac crest, to the nearest 0.1 cm, in a standing position during end-tidal expiration.

**Statistical analysis**

Collected data were checked for quality after each day’s data collection and entered in the Statistical Package for the Social Science software SPSS version 20.0, International Business Machines Corporation (IBM, New York, USA). Percentile charts were drawn for the BP values at the 5th, 25th, 50th, 75th, and 95th percentiles. Initially, continuous data were checked for normality distribution by Kolmogorov-Smirnov test. A nonsignificant P value indicated normal distribution of dataset. Thus, mean and standard deviation were used to represent central tendency and dispersion, respectively. The relationship between two continuous variables was assessed by Pearson’s product-moment correlation coefficient (r). P = 0.05 or less was considered as statistically significant.

**Results**

The mean BP in study participants was higher among higher age groups when compared to the lower age groups with exception at 16 years of age for SBP and at 16 and 18 years of age for DBP. The percentile values of SBP and DBP for different ages for the 5th, 25th, 75th, and 95th percentiles are shown in Table 1.

Mean SBP and DBP increased gradually with increase in anthropometric variables such as height, weight, waist circumference, and BMI. The mean SBP and mean DBP of the study participants increased with increase in height range except in case of mean DBP in height range of 160–170 cm. Significant positive correlation was obtained between SBP and height (r = 0.19) and DBP and height (r = 0.28), respectively. Mean SBP and DBP also increased uniformly with an increase in weight range and appeared to have significant positive correlation with weight with a correlation value of 0.48 and 0.47, respectively. A similar observation was also noted between BP and waist circumference and BP and BMI. Waist circumference and BMI too had a
Discussion

High BP is a major risk factor for cardiovascular and cerebrovascular diseases. The morbidity and mortality due to these diseases among adults is on the rise and more so in developing countries such as India. The long, slow, and steady course of hypertension suggests that it has its origin in childhood and adolescent. It probably goes undetected during this period and manifests later in life. Information on BP on different communities has come chiefly from various cross-sectional studies, which reveals its true epidemiological picture. The present study was done to find BP pattern among adolescent schoolboys and its relation with anthropometric measurements.

The present study showed an overall prevalence of elevated BP (systolic, diastolic, or both) to be 5.7%. SBP and DBP of study population appeared to have a positive correlation with weight (0.478 and 0.475, respectively), waist circumference (0.39 and 0.43, respectively), and height (0.19 and 0.28, respectively) which agreed with the observation of Chadha et al., Pramanik et al., Kumar et al., Chirag et al., Soudarssanane et al., and Bahl et al.

SBP and DBP of study population appeared to have a positive correlation with BMI (0.44 and 0.38, respectively) similar to the findings of Kumar et al. and Chirag et al. In a study by Ramalingam and Chacko in Tamil Nadu and Durrani and Waseem in Aligarh, they observed that mean SBP and DBP increased with mean weight, height, and BMI. Verma et al. in Punjab showed that the prevalence of hypertension was

**Table 1: Distribution of systolic and diastolic blood pressure according to age (n=894)**

| Age (years) | n  | SBP (mmHg) | Mean±SD | 5th | 25th | 50th | 75th | 95th |
|-------------|----|------------|---------|-----|------|------|------|------|
|             |    |            |         |     |      |      |      |      |
| 13          | 53 | 103.5±17.6 | 60.0    | 90.0| 104.0| 115.0| 131.5|
| 14          | 132| 104.8±11.9 | 80.0    | 100.0| 110.0| 110.0| 120.0|
| 15          | 166| 112.2±9.7  | 100.0   | 108.5| 110.0| 116.0| 130.0|
| 16          | 327| 111.4±7.9  | 100.0   | 110.0| 110.0| 112.0| 124.0|
| 17          | 165| 116.3±9.3  | 100.0   | 112.0| 118.0| 120.0| 130.0|
| 18          | 51 | 116.6±8.5  | 110.0   | 110.0| 120.0| 120.0| 136.8|

**Table 2: Distribution of systolic and diastolic blood pressure in relation to different anthropometric variables (n=894)**

| Variables            | n  | SBP           | Mean±SD | DBP            | Mean±SD |
|----------------------|----|---------------|---------|----------------|---------|
|                      |    |               |         |                |         |
| Weight (kg)          |    |               |         |                |         |
| 30-40                | 116| 101.20±13.0   | 67.39±10.5| 65.50±9.3     |
| 40-50                | 390| 110.65±7.4    | 71.38±7.3| 68.80±8.3     |
| 50-60                | 269| 112.70±10.1   | 74.65±7.6| 70.0±9.0      |
| 60-70                | 78 | 117.90±10.3   | 80.2±8.7 | 75.0±9.0      |
| ≥70                  | 41 | 124.04±11.2   | 85.02±7.6| 80.0±9.0      |
|                      |    | r, P          |         |                |         |
|                      |    | 0.48, <0.05*  |         | 0.47, <0.05*   |         |
| Height (cm)          |    |               |         |                |         |
| 130-140              | 40 | 106.50±13.6   | 65.50±9.3| 68.80±8.3     |
| 140-150              | 185| 112.50±11.2   | 75.28±8.6| 74.13±8.7     |
| 150-160              | 391| 110.95±10.4   | 74.65±7.6| 70.0±9.0      |
| 160-170              | 241| 110.99±10.5   | 74.13±8.7| 70.0±9.0      |
| ≥170                 | 37 | 115.95±7.8    | 76.49±5.9| 75.28±8.6     |
|                      |    | r, P          |         |                |         |
|                      |    | 0.19, <0.05*  |         | 0.28, <0.05*   |         |
| Waist circumference (cm) | 45-60 | 153 | 101.35±11.9 | 65.28±8.7 |
|                      | 60-75 | 611 | 112.99±9.2  | 74.06±8.2 |
|                      | ≥75  | 130 | 114.97±9.6  | 78.77±6.8 |
|                      |    | r, P          |         |                |         |
|                      |    | 0.39, <0.05*  |         | 0.43, <0.05*   |         |
| BMI (kg/m²)          |    |               |         |                |         |
| 12-17                | 97 | 100.76±10.5   | 66.78±9.5| 72.65±8.2     |
| 17-22                | 525| 110.98±9.7    | 72.65±8.2| 74.06±8.4     |
| 22-27                | 198| 112.50±6.9    | 74.06±8.4| 73.0±10.7     |
| ≥27                  | 74 | 124±12.3      | 83.70±10.7| 83.70±10.7   |

|                      |    | r, P          |         |                |         |
|                      |    | 0.44, <0.05*  |         | 0.38, <0.05*   |         |

*Pearson’s correlation coefficients were statistically significant.

SD: Standard deviation, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure
much higher (13.7% vs. 0.4%) in obese as compared to nonobese children \( (P < 0.01) \). Mohan et al.\[^{20}\] in Ludhiana found a significant increase in the prevalence of hypertension in both rural and urban population with increased BMI in urban students, and mean BMI of hypertensive population in both rural and urban areas was significantly higher than respective normotensive population \( (P < 0.05) \). Lifestyle modification such as increased physical activity and healthy dietary habits can prevent the consequences of high BP in later life.

**Limitation**

In this cross-sectional study, students who were found to have higher BP values could not be followed up to determine the actual BP status. BP influenced by numerous factors such as time of day (diurnal variation), season of the year, and fasting versus nonfasting state of the participant, all of which could not be controlled during the present investigation.

**Conclusion**

The present study revealed that the proportion of high BP was more in the participants, whose body weight, height, waist circumference, and BMI were in the higher range, and positive correlation was found with anthropometric variables. Early detection of high BP and maintenance of normal weight, waist circumference, and BMI as per standard norms might be helpful in reducing the burden of high BP in adult life. Effective policies for adolescents can be made to decrease the morbidity and complications arising out of high BP in the long run.

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**Conflicts of interest**

There are no conflicts of interest.

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