RESEARCH ARTICLE

BLOOD PRESSURE DISTRIBUTION AND ITS ASSOCIATION WITH ANTHROPOMETRIC MEASUREMENTS AMONG ASIAN INDIAN ADOLESCENTS IN AN URBAN AREA OF TAMIL NADU

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ABSTRACT
Background: Overweight and obesity has become a global public health burden. Compounded with this there is an increase in non-communicable diseases such as cardiovascular diseases, diabetes and hypertension. Early tracking of blood pressure is effective in introducing preventive measures.
Aims & Objective: The objectives of this study were to assess the prevalence of high blood pressure among adolescents aged 10-15 years in urban schools and to study the association of the anthropometric measurements on the blood pressure.
Materials and Methods: This is a cross sectional study involving 3624 school children aged between 10-15 years in the schools of the catchment area of the urban health centre affiliated to the Department of Community Medicine. Anthropometric measurements along with blood pressure measurements twice each ten minutes apart was done. The mean blood pressure values were included for the study.
Results: Defining ≥ 95th percentile as hypertension, 153 (10.2%) females and 177 (8.3%) males were hypertensive. Totally there were 330 subjects (8.3%) hypertensive in the study group. There was no significant difference in the prevalence of hypertension between the genders. A rise is observed in mean systolic and diastolic BP with increase in mean weight, height and BMI. There were 173 (4.8%) children who were overweight and 30 (0.8%) children who were obese. Among the overweight children, 62 subjects (35.83%) were hypertensive. Among the children who were obese, 19 (63.3%) were hypertensive. There was also a correlation between body mass index and hypertension.
Conclusion: The study points out the need for early screening for high blood pressure in school students and introducing effective lifestyle modifications at an early age to prevent the epidemic of non-communicable diseases in future.
Key Words: Blood Pressure; Obesity; Hip Circumference; Waist Circumference; Height; Body Mass Index; Anthropometry

Introduction

Hypertension is one of the most common public health problems globally among adults, and recent data suggests that there is an increase in the incidence of childhood hypertension as well.[1] Hypertension is a well-known risk factor for cardiovascular diseases and hypertension in adults often begins in the childhood.[2] Many environmental and genetic factors play a significant role in the causation of blood pressure such as the age, gender, body size, body mass index, physical activity, diet and stress levels. However, during adolescence, the main influencing factor that leads to hypertension is obesity and metabolic syndrome and familial factors of hypertension. In spite of it being a risk factor for cardiovascular diseases, high blood pressure is often under diagnosed in children.[3] Over the last decade, there has been a rise in the incidence of overweight and obesity along with physical inactivity, raising the risk of hypertension and cardiovascular diseases both in the developed and developing countries alike. A recent report by the WHO has shown that over a 43 million children under the age of five were overweight in 2010. Once considered a high-income country problem, overweight and obesity are now on the rise in low- and middle-income countries, particularly in urban settings.

Close to 35 million overweight children are living in developing countries and 8 million in developed countries.[1] The prevalence of overweight and obesity has led to an increase in insulin resistance along with a concomitant rise in blood pressure in children.[3] Hence it becomes important to detect hypertension and its precipitating and aggravating factors if one has to evolve appropriate preventive measures. Recent data from the United States suggest that over the last decade, there is a substantial rise in the average BP levels in children.[4,5] There is a paucity of data on BP profile in Indian children with very few showing different patterns of normal blood pressure.[6-8] The present study aims to determine the distribution of blood pressure and prevalence of hypertension among children between age group 10-15 years and correlate it with their anthropometric measurements.

Materials and Methods

This cross sectional study was carried out among 3624 school children between the age group 10-15 years in the schools of the catchment area of the urban health centre affiliated to the Department of Community Medicine at PSG Institute of Medical Sciences and Research, Coimbatore, India. There were five private schools and one Government school in the study. The project was cleared by the Institutional Ethics Committee and an informed consent was obtained from the parents of the children and the school authorities. All the children underwent a thorough clinical examination to rule out secondary causes of hypertension and their anthropometric measurements such as weight, height, hip circumference and waist circumference were recorded. All health workers and staff who accompanied the investigator to these schools were given one days training on taking anthropometric measurements. Blood pressure (BP) was measured by the same person throughout the study to minimize the inter observer bias. All the equipments were standardized and validated prior to each school visit. The age of each child was documented from the school records. If a few children were found absent during the first visit, a second visit was made to ensure that the absentees were not excluded from the study. If the student was absent during the second visit also, he/she was not included in the study.

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Measurement of Blood Pressure: Blood pressure measurement was taken using the sphygmomanometer (ELKO) with the standard cuff appropriate for the age. BP was measured by the same individual throughout the study. The children were made to sit quietly for 5 minutes, and seated with his or her back supported, feet on the floor and right arm supported, cubital fossa at heart level and the blood pressure was measured in the right arm. The phase I of Korotkoff's sound (appearance of one or more sounds) was considered for systolic blood pressure and Phase V of Korotkoff's sound (point at which the sound disappears) was considered as the diastolic BP. Two values were taken at 5 minutes interval and the mean was taken for the study purpose.[9] Anthropometric measurements as weight, height, hip circumference and waist circumference were also measured using the WHO standards.[10]

Measurement of Weight: The weight of the children was measured using the conventional weighing scales. These scales were calibrated before each school visit using known weights. The children were asked to stand on the weighing scale with light clothing and without shoes and the weight was measured to the nearest 0.5kg.

Measurement of Height: Height was measured using a portable stadiometer (Biocon™). It is a wall mountable type of stadiometer which had measurements up to 200 cm.

Measurement of Hip Circumference: With the child standing erect with arms at the sides and feet together, the measurer sitting at the side of the subject so that the level of the maximum extension of the buttocks can be seen, the measuring tape is placed around the buttocks in the horizontal plane. The tape is snug and the reading is made to the nearest 0.1 cm.

Measurement of Waist Circumference: The waist circumference was taken after asking the subjects to raise their shirts and the midpoint between the lowest rib and the anterior superior iliac spine is taken and the measuring tape is placed snugly around this point and the reading is made to the nearest 0.1cm.

Statistical Analysis: The collected data were analysed using SPSS version 19. The children were classified into overweight and obese based on the International Obesity Task Force (IOTF) classification. Percentile charts were drawn for the blood pressure values at 5th, 10th, 25th, 90th and 95th percentile. Those with systolic blood pressure, diastolic blood pressure or both above the 95th percentiles of the predicted value for their respective age were considered to have systolic hypertension, diastolic hypertension or overall hypertension, respectively. Additionally, those with systolic blood pressure over 130 mm Hg, diastolic blood pressure over 80 mm Hg or both were considered to have systolic, diastolic or overall hypertension respectively. Unpaired two-sample t tests were carried out to compare the means of the anthropometric variables between normotensive and hypertensive subjects. Correlation coefficient was studied to measure the association between the blood pressure and anthropometric variables.

Results

The study population comprised of 3624 children between the age group of 10-15 years of which 1500 (41.4%) were females and 2124(58.6%) were males. Table 1 shows the baseline characteristics of the study population in terms of weight, height, BMI, waist circumference, hip circumference, waist hip ratio, systolic and diastolic blood pressures.

Table-1: Clinical Characteristics of the study population

Variables	Boys Mean (SD) (n=2124)	Girls Mean (SD) (n=1500)	Total Mean (SD) (n=3624)
Age	12.53 (1.26)	12.46 (1.24)	12.38 (1.21)
Hip Circumference	72.15 (8.79)	74.95 (8.67)	73.31 (8.85)
Waist Circumference	60.78 (8.96)	59.38 (7.59)	60.20 (8.45)
Waist Hip Ratio	0.84 (0.06)	0.79 (0.06)	1.29 (0.822)
Body Mass Index	16.05 (2.90)	16.80 (2.98)	16.36 (2.96)
Height	147.07 (10.92)	148.01 (9.49)	147.83 (10.35)
Weight	35.55 (9.80)	37.22 (9.27)	36.24 (9.63)
Systolic Blood Pressure	106.32 (11.39)	108.34 (11.26)	107.16 (11.38)
Diastolic blood pressure	69.59 (8.80)	70.10 (8.80)	71.00 (8.77)

Table 2: Distribution of systolic and diastolic blood pressure by age

Age (Years)	N	Percentile						
		Mean	5th	10th	25th	75th	90th	95th
Systolic Blood Pressure (mmHg)								
10	132	104.20	90	90	100	110	119.4	120
11	787	106.17	90	90	100	110	120	120
12	955	106.18	90	90	100	110	120	124.4
13	926	107.51	90	90	100	114	120	130
14	644	109.12	90	92	100	120	120	130
15	180	110.05	90	100	100	120	124.85	130
Diastolic Blood Pressure (mmHg)								
10	132	67.39	60	60	60	70	80	80
11	787	68.80	60	60	60	70	80	80
12	955	70.17	60	60	60	80	80	82.4
13	926	70.71	60	60	60	80	80	86
14	644	71.06	58.5	60	64	80	80	90
15	180	72.2	60	60	60	70	86	90

Table-3: Age wise prevalence of hypertension

Age	Females		Males	
	Total	Hypertensive (%)	Total	Hypertensive (%)
10	70	9 (12.9)	62	10 (16.1)
11	327	48 (14.7)	460	46 (10.0)
12	408	34 (8.3)	547	44 (8.0)
13	397	35 (8.8)	529	43 (8.1)
14	251	25 (10.0)	393	21 (5.3)
15	47	2 (4.3)	133	13 (9.8)
Total	1500	153 (10.2)	2124	177 (8.3)

An univariate analysis (χ^2 test) did not show any significant difference in the prevalence of hypertension between the genders (p = 0.301, >0.01).

Table-4: Pearson's Correlation Coefficient

Variables	Systolic BP	Diastolic BP
Height	0.333	0.298
Weight	0.443	0.421
Waist Circumference	0.326	0.322
Hip Circumference	0.391	0.383
Body Mass Index	0.388	0.381

Correlation Coefficient is significant (p<0.01, two tailed).

The means of the anthropometric variables such as the height, weight, waist circumference and hip circumference were significantly higher in the hypertensive individuals when compared to that of normotensive individuals (p<0.001). The percentile curves were drawn for different ages for the 5th 10th, 25th, 75th, 90th and 95th percentile (Table 2). Defining ≥ 95th percentile as hypertension, 153 (10.2%) females and 177(8.3%) males were hypertensives. Totally there were 330(8.3%) hypertensive subjects in the study group. The age wise prevalence of hypertension was enlisted (Table 3). There was no significant difference in the prevalence of hypertension between the genders. A rise is observed in mean systolic and diastolic BP with increase in mean weight, height and BMI. There were 173(4.8%) children who were overweight and 30 (0.8%) children who were obese. Among the overweight children, 62 (35.83%) were hypertensive subjects. Among the children who were obese, 19 (63.3%) were hypertensive subjects. The correlation coefficients of SBP and DBP with height were 0.333 and 0.298, respectively. Mean SBP and DBP were higher as weight increased with correlation coefficient of SBP being 0.443 and correlation coefficient for DBP being 0.421. Increase in body mass index resulted in a corresponding increase in systolic and diastolic BP in both sexes with correlation coefficients of 0.388 and 0.381 for SBP and DBP, respectively. Hence, systolic as well as diastolic BP had a positive correlation with anthropometric variables and is significant at 0.01. (Table 4)

Discussion

Hypertension is a major risk factor for cardiovascular and cerebrovascular diseases. The risk of morbidity and mortality due to these diseases among adults is on the rise and more so in developing countries such as India. Many cases of hypertension in adults begin during childhood both in males and females. The present study showed an overall prevalence of elevated blood pressure (systolic, diastolic or both) to be 9.1%. There was no difference between male and female with regard to the prevalence. Comparison of data sets from US adolescents demonstrated an increasing trend for high blood pressure among adolescent girls in contrast to a decreasing trend for the same in adolescent boys.[15] The onset of sexual maturation is associated with increases in systolic and diastolic blood pressures.The overall prevalence recorded in our study was similar to that of Durrani and Fatima[12] who observed a prevalence of 9.2% in their study among adolescents between 12-16 years in Aligarh, India. Our prevalence rates were slightly lower than the observations made by A Chiolero et al in their study among adolescents in Seychelles. [16] Higher prevalence rates are noted in studies done among Hispanics (21%).[17] Various other studies in India have reported prevalence rates ranging from 5.2% to 12%.[14,15,18] The wide variation in the prevalence could be because of a lack of a standard cut off value for blood pressure in Indian children and each investigator using a different definitions for high blood pressure (Table 5). The Fourth Report on the diagnosis, evaluation and

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treatment of high blood pressure in children and adolescent on hypertension which is commonly used are based on the anthropometric values of US adolescents. Few studies like ours have derived their own population specific percentile values to measure the prevalence.[10,20] A recent study published by Manu Raj et al on blood pressure distribution among 20,000 Indian children has attempted to draw height based blood pressure percentiles. However, this study is limited to adolescents in Kerala.[21]

Table-5: Prevalence of hypertension among adolescents – Published studies in India

Author	Year	Sample & Age	Prevalence
Gupta, A. K. et al[6]	1990	3861 (5-15 years)	0.50%
Verma M et al[13]	1994	2562 (5-15 years)	13.11%
M.B. Soudarssanane et al[20]	2006	673 (15-19 years)	8.50%
Khan M I et al[23]	2010	1093 (12-19years)	9.78%
Simonetta Genovesi et al[17]	2011	1176 (5-12 years)	5.20%

Our study also revealed a positive correlation between BMI, weight, height and blood pressure values. A similar observation has been made in a study that revealed that Asian children living in Australia who become overweight or obese have a higher risk of developing high BP compared to their peers from other ethnic groups.[19] Our observation was in agreement with studies carried out by other investigators.[12,18] In addition, we also observed a positive correlation between hip circumference, waist circumference and blood pressure. This was in agreement with a study carried out by Ruchika Goel et al who studied the correlates of hypertension and various markers of obesity among adolescents in New Delhi.[22]

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This study has certain limitations. As this is a cross sectional study, blood pressure was measured only twice in 5 minute interval during the school visit. These children who were found to have a higher blood pressure values need to be followed up to determine the blood pressure status. A third or fourth measurement of blood pressure could have possibly lowered the number of hypertensive children. Furthermore, we have not systematically studied or adjusted for factors such as salt intake, physical activity and dietary habits, which would be pertinent for future surveys.

Large scale community based multicentric studies representing different age groups and socioeconomic strata are recommended so that region and age specific cut off values can be drawn for Indian adolescents which, in turn would give a true estimate of the prevalence of high blood pressure values in our country.

The association between overweight and elevated BP in children would reflect on an increased burden of hypertension-related diseases as the obesity epidemic further goes up. Prevention of cardiovascular risk factors as early as in childhood – also called primordial prevention – may be an important strategy to prevent non-communicable diseases in a life course perspective, particularly in settings with scarce resources. This study reemphasizes the pressing need to develop a comprehensive medical and nutrition plan together with preventive and corrective strategies in school programmes to reduce the prevalence of these identified disease states, by empowering parents, teachers and policy makers to realize the need for increased physical activity, healthy dietary habits together with lifestyle.

Conclusion

The study points out the need for early screening for high blood pressure in school students and introducing effective lifestyle modifications at an early age to prevent the epidemic of non-communicable diseases in future.

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