Original Research Article

Blood pressure and its correlation with age and BMI among the school children aged between 10 and 16 years

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Abstract

Background: A trend in blood pressure over a period of time in children is important predictor of subsequent trends in adult hypertension. Although blood pressure normally increases with growth and development, children with higher levels of blood pressure intend to maintain that position relative to their peer group as they mature or track into higher levels of blood pressure in adulthood and BMI acts as a major risk factor for hypertension not only in adults but also among children. **Aim:** To assess the prevalence of overweight, obesity and hypertension among children aged 10 to 16 years and also to assess the association between BMI, age and blood pressure. **Methodology:** A cross-sectional study was conducted for period of one year in the field practicing area of our medical college hospital. All children aged between 10 and 16 years irrespective of gender were included as our study subjects. A total of 1060 school children were included in our study. A semi-structured questionnaire was designed to collect the information regarding the demographic details of the children and for all the children weight and height was measured and BMI was calculated and the blood pressure was measured using sphygmomanometer using the appropriate cuff size for the age. **Results:** The correlation between BMI and hypertension showed a strong positive correlation between BMI and systolic BP among both males (r=0.827) and females (r=0.714) and the correlation was found to be statistically significant whereas among BMI and diastolic BP among males (r=0.838) it showed a statistically significant correlation but among females (r=0.515) the correlation between BMI and diastolic BP was not found to be statistically significant. **Conclusion:** As high BP was found to be strongly associated with overweight/ obesity in this study, we recommend screening of BP should be carried out routinely in children and adolescents.

Keywords: hypertension, BMI, children.

Introduction

Overweight is defined as excess body weight for a particular height and the term obesity is used to define excess body fat [1]. Both this overweight and obesity primarily occurs due to increase in calorie intake and decreased physical activity, as this being a multifactorial causation various other factors like genetic, behavioural, and environment also play a significant role in its pathogenesis. Childhood obesity is a major risk factor for metabolic syndrome and various other non-communicable diseases like diabetes, hypertension, coronary artery disease, stroke, cancer, mental disorders and respiratory problems [2]. In India nutritional problems among children and adolescents face a double edge sword where one end of spectrum we have undernutrition, wasting and stunting and the other end is overweight and obesity. Globally, in the recent past the prevalence of childhood obesity had seen a sudden increase. The International Association for the Study of Obesity (IASO) and International Obesity Task Force (IOTF) estimate that 200 million school children are either overweight or obese [3]. It is difficult to compare prevalence rates of childhood obesity in different countries due to several limitations: lack of nationally representative surveys of school children and paucity of serial measurements over time.

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There are a few studies, reporting, prevalence of childhood and adolescent obesity and overweight from different parts of India (Punjab, Maharashtra, Delhi and South India) that range from 3% to 29%, and also indicate that the prevalence is higher in urban than in rural areas [4].

In most studies, slightly higher prevalence rates were reported in boys, compared to girls. The criteria used in these studies for overweight and obesity were based on American and European BMI standards [5].

In these standard the cut-off value fixed was >85th percentile for overweight and > 95th percentile for obesity which have been derived from the data from National Center for Health Statistics (NCHS) and National Health and Nutrition Examination Survey (NHANES) [6,7].

Hypertension is a major health problem in developed and developing countries affecting one billion individuals worldwide (JNC-VII Report 2003) and this is expected to increase to 1.56 billion by 2025.
Although the prevalence is far lower in children and adolescent, but the evidence indicates that hypertension begins to develop during the first two decades of life [8,9].

A trend in blood pressure overtime in children is important predictors of subsequent trends in adult hypertension. Luepker etal observed that although blood pressure normally increases with growth and development, children with higher levels of blood pressure intend to maintain that position relative to their peer group as they mature or track into higher levels of blood pressure in adulthood [10].

Hypertension being a major risk factor for most of the coronary and cerebral vascular diseases had served as an impetus for paediatricians to routinely include measurement of blood pressure as an integral part of paediatric physical examination. In the hospitalised patient it is considered an important and routine as documentation of body temperature, pulse rate and respiratory rate. In the out-patient clinics it is now common practice to measure and record the B.P. in all children above three years of age.

However, very few studies are available with reference to blood pressure and BMI among children in Tamilnadu. Therefore, in the present study, an attempt has been made to report the variation in blood pressure with respect to BMI and age among the school children.

Aim

To assess the prevalence of overweight, obesity and hypertension among children aged 10 to 16 years and also to assess the association between BMI, age and blood pressure.

Methodology

Study type: A cross-sectional study was conducted for period of one year

Study place: In the field practicing area of our medical college hospital. The field practicing area of Vinayaka Missions Medical College Hospital is situated at around 8 kms from hospital, the name of the rural area is Attayampatti which has a population cover of roughly 25,000.

Sampling method: In that village only 2 government schools are functioning and for our study we selected both the schools

Inclusion criteria: School children aged between 10 and 16 years irrespective of gender were included as our study subjects.

Exclusion criteria: Children presenting with acute illness, history suggestive of cardiovascular, respiratory or any other systemic illness, handicapped children and children with any disability were excluded from the study.

Sample collection: A total of 1060 school children were included in our study. The study was started after getting clearance from the institutional ethical committee and informed consent was obtained from the head master of the school for conducting the study in the school. A semi-structured questionnaire was designed to collect the information regarding the demographic details of the children and for all the children weight and height was measured and BMI was calculated and blood pressure was assessed. Height was measured by using a vertical scale to the nearest 0.5 cms. Weight was measured using a standard weighing scale to the nearest 0.5 kgs. The international cut off points for body mass index were used for classifying children as overweight and obese.

The instrument used for measuring the blood pressure was mercury sphygmomanometer in conjunction with a good stethoscope for all ages. In all the cases brachial artery was routinely felt and then the right upper limb was used for recording blood pressure as it is the direct continuation of ascending aorta. Blood pressure was recorded in the right upper limb. The standard BP cuff was firmly placed over the brachial artery and inflated to 30mm above the systolic BP recorded by palpatory method, then the cuff is deflated by 2-4 mm of Hg per second.

The appearance of 1st korotkoff sound and muffling of korotkoff sounds were taken as systolic and diastolic pressure respectively. Three readings were taken at an interval of 5 minutes each and average of the three reading taken as systolic and diastolic blood pressure respectively.

Before recording the blood pressure, children in groups of 10 were taken to a separate room away from noise, and they were explained in detail, the procedure of blood pressure recording and they were reassured that the procedure is neither painful, nor harmful.

All efforts were made to eliminate factors which might affect the blood pressure such as anxiety, fear, crying, laughing, recent activities in order to facilitate the blood pressure recording under simulated "basal" or "near basal" conditions. Blood pressure was recorded only when the child had become accustomed to the observer, instrument and surroundings.

After giving rest for 5-10 minutes blood pressure was recorded in sitting position with his back supported, feet on the floor and right arm supported with cubital fossa at heart level. Right arm was used for consistency and for comparison with standard tables and because of the possibility of coarctation of the aorta, which might lead to false (low) readings in the left arm. Blood pressure recordings were expressed to the nearest 2 mm Hg.

All blood pressure recordings were taken on the same time of the day, i.e. during afternoon hours and recorded by the same person and by same instrument. Systemic examination was also done to exclude cardiovascular, renal and other diseases which could affect blood pressure.

BMI between 85^{th} and 95^{th} percentile is called over weight and >95^{th} percentile is obese, <5^{th} percentile is underweight. Similarly when the SBP and DBP were higher than 95^{th} percentile (for age and sex), they were considered as hypertensive as per charts according to 'Fourth Report On The Diagnosis, Evaluation, And Treatment of High Blood Pressure In Children And Adolescents' given in 'Evaluation And Management of Hypertension', by Bagga A. etal [11].

Statistical analysis: All data were entered and analysed using SPSS version 22. Mean and standard deviation was calculated for all the parametric variables.

Chi-square test and pearson's correlation coefficient were used to derive statistical inference between the two variables namely the BMI and blood pressure.

Results

In our study among the total 1060 children 522 were boys and 538 were girls and the male: female ratio was 0.97: 1. Among the different age group from 10 to 16 years majority were in the age of 12 years and in all the other age group there was almost equal distribution of students both among males and females and the mean age among males was 12.7 years and that of among females it was 12.9 years (table 1).

Table-1: Age and gender wise distribution of the study subjects.

Age in years	Male	Female	Total
10	58 (11.1%)	58 (10.7%)	116 (10.9%)
11	50 (9.5%)	70 (13%)	120 (11.3%)
12	90 (17.2%)	112 (20.8%)	202 (19%)
13	86 (16.4%)	96 (17.8%)	182 (17.1%)
14	78 (14.9%)	90 (16.7%)	168 (15.8%)
15	84 (16%)	64 (11.8%)	148 (13.9%)
16	76 (14.5%)	48 (8.9%)	124 (11.7%)
Total	522 (100%)	538 (100%)	1060 (100%)
Mean ± SD	12.7±3.8	12.9±4.2	12.8 ± 3.9

Table-2: Age wise distribution of the mean weight, height and BMI of the study subjects.

Age	Weight (kg)	Height (cm)	BMI	P value
10	25.85 ± 4.8	127 ± 8.4	16.08 ± 1.8	<.001
11	29.17 ± 5.2	134 ± 10.1	16.14 ± 2.1	
12	31.64 ± 5.9	138 ± 9.8	16.68 ± 2.6	
13	36.69 ± 6.1	144 ± 10.6	17.71 ± 2.2	
14	38.78 ± 5.5	147 ± 11.2	17.80 ± 2.8	
15	42.71± 6.4	152 ± 13.6	18.61 ± 3.1	
16	49.8 ± 5.3	156 ± 12.8	20.46 ± 2.9	

P value derived by applying student T test

The mean BMI among 10 years old children was 16.08 and it was 20.46 among the children aged 16 years and it was observed in our study that there was a steady increase in the BMI as the age of the children increases and this increase in BMI as the age increases was found to be statistically significant (table 2)

Table-3: Age and gender wise prevalence of hypertension among the study subjects.

Age	Male			Female		
	Total	Hypertension	%	Total	Hypertension	%
10	58	12	20.69	58	8	13.79
11	50	8	16	70	6	8.57
12	90	12	13.33	112	10	8.92
13	86	10	11.63	96	12	12.5
14	78	4	5.12	90	10	11.11
15	84	12	14.29	64	6	9.38
16	76	6	7.89	48	4	8.33
Total	522	64	12.26	538	56	10.40

The overall prevalence of hypertension among the males was 12.26% and among females it was 10.4% and the highest prevalence of hypertension both among males (20.6%) and females (13.7%) was observed in the age group of 10 years whereas in all the other age group the prevalence of hypertension among males it ranged between 8 – 13% and among females it was between 8 and 12% (table3).

Table-4: Association between BMI and hypertension among the study subjects.

BMI	Male			Female			Total		
	Total	Hypertension	%	Total	Hypertension	%	Total	Hypertension	%
Normal	320	26	8.125	342	29	8.47	662	55	8.31
Over weight	36	12	33.33	58	12	20.68	94	24	25.53
Obese	20	8	40	34	15	44.12	54	23	42.59
Under weight	146	14	9.58	104	6	5.76	250	20	7.67
P value	<.001			<.001			<.001		

P value derived by applying Chi-square test

As per the percentile the BMI was classified as normal, overweight, obese and underweight. It is seen from table 4 that the prevalence of hypertension was more among the students in overweight and obese category than that of normal or underweight category both among males and females and this association between BMI and hypertension was found to be statistically significant.

Table-5: Correlation between BMI and hypertension among the study subjects.

Blood pressure	BMI	Male (mean ± SD)	Female (mean ± SD)
Systolic BP	Normal (80-85th percentile)	116.6 ± 5.19	122.43 ± 3.63
	Over Weight (85 – 95th percentile)	123.3 ± 8.45	123.33 ± 3.34
	Obese (>95th percentile)	128.16 ± 3.09	124.67 ± 3.19
	Under Weight (<5th percentile)	115.53 ± 4.46	117.34 ± 1.15
R value (p value)		0.827 (<.001)	0.714 (<.001)
Diastolic BP	Normal (80-85th percentile)	80.6 ± 0.84	78.34 ± 1.79
	Over Weight (85 – 95th percentile)	81.5 ± 3.5	80.67 ± 2.3
	Obese (>95th percentile)	89.2 ± 3.43	81.33 ± 3.08
	Under Weight (<5th percentile)	78.67 ± 2.07	76.2 ± 2.78
R value (p value)		0.838 (<.001)	0.515 (0.071)

The correlation between BMI and hypertension showed a strong positive correlation between BMI and systolic BP among both males (r=0.827) and females (r=0.714) and the correlation was found to be statistically significant whereas among BMI and diastolic BP among males (r=0.838) it showed a statistically significant correlation but among females (r=0.515) the correlation between BMI and diastolic BP was not found to be statistically significant (table 5).

Discussions

Hypertension is a major risk factor for cardio and cerebrovascular diseases [12-14]. Most of the studies done on hypertension carried out in different populations had shown a rise of blood pressure as the age advances [15]. Kotchen et al, in his study had shown an insidious and steady course of hypertension in adults, indicates that it may have its roots in childhood and adolescent age group but might have probably gone undetected [16]. Further, Agarwal etal, in his recent work suggested that blood pressure level correlates better with body mass index in children and adolescents than that of age [17].

It is not clear what level of blood pressure should be considered distinctly abnormal for a given age or BMI. Various studies had quoted the prevalence of hypertension in children ranged from 1.0 to 16.2% [18-20]. In the above studies the high incidence of hypertension may be due to inclusion of transient hypertension. Hypertension in children was defined as blood pressure above the 95th percentile recorded on three different occasions. Many authors agree that serial determination of blood pressure is necessary in order to document persistent elevations [21,22]. Sustained severe hypertension can almost always be related to a definite cause, however population based epidemiological studies show that primary hypertension is predominant among apparently healthy children.

Aggarwal etal in his study quoted that various definitions have been used to identify hypertension in adolescents and the re screening has resulted in lower prevalence rate in several studies [17]. In order to study the variations in blood pressure over various ages it is necessary to study the normal range of blood pressure among children. A considerable work has been done in different parts of India to establish the normal blood pressure variation for different age groups. However very few studies are available with reference to blood pressure among children in Tamilnadu. The prevalence of hypertension in school children of the current study is 12.26% in boys and 10.4% in girls. In the present study the value of systolic blood pressure and diastolic BP is slightly lower among girls than boys, but the difference was not statistically significant in most of the age groups.

This is consistent with findings of Laroia et al., Voors et al, Anand and Tandon et al, Chadha et al [23-26]. In our study the prevalence of overweight was 4.43% and obesity was 2.55% which was in comparable with study done by Bisavmohan et al, with 11.63% of overweight and 2.35% obese in urban areas but our study group comprises of subjects from middle and lower socio economic status [27]. The overall prevalence of hypertension in overweight children is 25.53% (n =12) and in obese children it is 42.59% (n = 23), whereas with normal body mass index the prevalence was only 8.31% (n=55).

The mean body mass index of hypertension population was significantly higher than respective normotensive population. The mean systolic and diastolic BP of overweight and obese children is higher than their normotensive counterparts. A similar study done by Sharma et al in Shimla noted that rates of elevated blood pressure (prehypertension and hypertension) were significantly higher (P<0.001) among those with high BMI (overweight and obese) compared to those with normal BMI [28]. Study done by Dyson et al analysed Anthropometric data collected from 12,730 school children aged 12-18 years in China, India and Mexico as part of the Community Interventions for Health programme, an international study evaluating community interventions to reduce non-communicable disease [29].

They came to similar conclusion that there was a significant association between overweight and obesity and rates of hypertension and overweight children were 1.7-2.3 times more likely to be hypertensive and obese children 3.5-5.5 more likely to show hypertension than those of normal weight. In both boys and girls in all three countries, the odds for hypertension increased incrementally with each BMI category. Study done by Krishna et al at Bangalore and Haveri in 2001-02 have showed that undernourished children have significantly reduced (P<0.05) levels of systolic and diastolic blood Pressure and that blood pressure was found to be associated with BMI both in normal and obese children [30]. As indicated in the study, weight gain is almost invariably associated with an increase in BP. Thus prevention of weight gain should be a primary therapeutic target for reducing the problem of hypertension.

Conclusion

In terms of the relationship between high BP and BMI it showed a high positive correlation with a statistical significant association. As high BP was found to be strongly associated with overweight/ obesity in this study, we recommend screening of BP should be carried out routinely in children and adolescents. Early identification of hypertension and pre-hypertension translates into early interventions and possibly prevention of later morbidity and mortality.

What this study add to the existing knowledge: Periodic surveys should be done in schools to identify the “at risk” group of children and adolescents who can develop hypertension in future, so that preventive care can be provided and further emphasize for future research in adolescents by using all three steps of WHO stepwise approach and to measure overweight/obesity by using BMI along with other anthropometric methods such as waist circumference would improve the validity of the study.

Author’s contribution

- Dr.K.Rangasamy– Preparing the complete manuscript
- Dr. M.V. Senthamarai – Technical expertise
- Dr. R Shankar – Statistical analysis

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