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Study of blood pressure status and body mass index among primary school children

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Abstract
Background: Childhood overweight/obesity and hypertension are on the rise and limited data are- available regarding the profile of obesity and hypertension from rural parts of India. The present study was conducted with objectives of finding the prevalence of Elevated Blood pressure/hypertension in a representative sample of primary school children and the relationship between Body Mass Index (BMI) and Elevated Blood pressure/hypertension in study population.
Methods: This cross-sectional study was conducted by the Department of Pediatrics, Medical College from Western Maharashtra. Data was collected from Government aided primary and private run primary school children. Anthropometric measurements of school children between ages 6-11 years were taken to calculate BMI. Blood pressure was also measured.
Results: Amongst the 388 children, the prevalence of hypertension was 5.67% and that of pre-hypertension was 3.35%. Increasing BMI was associated with increase mean systolic blood pressure (mSBP) and mean diastolic blood pressure (mDBP). Children with higher BMI were associated with higher prevalence of pre-hypertension and hypertension.
Conclusion: Prevalence of childhood elevated blood pressure/hypertension, overweight and obesity is on the rise even in rural parts of India. Possible related factors for this current trend may be due to lack of physical activities, faulty eating habits, and increased salt/fat content of diet. The result suggests the need for blood pressure check-up for children during school health check-up and having periodic health educational programs to motivate students to adopt healthy lifestyle and food habits.

Keywords: blood pressure, BMI, hypertension, obesity, school children

Introduction

India is experiencing a rapid health transition; within India, in some of the states this transition is heavily influenced by western living pattern including sedentary lifestyle with high cardiovascular (CVD) risk profile [1].

The most widely used method to gauge obesity is the body mass index (BMI), which is equal to weight /height^2 (in kg/m^2). BMI changes throughout the growth and development of a child. It can be used as an indicator for tracking body size throughout the life cycle. As BMI increases throughout the range of moderate and severe overweight, so also does the risk increase for cardiovascular complications including hypertension. Although BMI is widely used as a surrogate measure of adiposity, it is a measure of excess weight relative to height rather than excess body fat.

The origin of adult obesity and its adverse health consequences often begins in childhood. Children who gain more weight during childhood are at increased risk for hypertension, dyslipidemia, and heart disease [2].

In children and adolescents, changes in blood pressure are associated with growth and maturation. NIH of USA has recommended that blood pressure (BP) measurement should be part along with weight and height measurement, which has to be done in children at least once a year.

Childhood elevated blood pressure is on rise. Evidences across the globe have documented prevalence of childhood hypertension as1-2% in the developed countries and 5-10% in the developing countries [3]. The prevalence of hypertension in various Indian studies ranges from 2.7% to 6.64% [4, 5].

The present study was undertaken to find the prevalence of elevated blood pressure / hypertension and it's relationship with BMI.

Methods

This cross-sectional study was conducted in pediatric department of an educational health institution from Western Maharashtra in the month of March 2019 after getting approval of the Institutional Ethical Committee. This study was a school-based study and the students selected for this study were from one Government and a private primary school. Totally 388 school students including both boys and girls in the age group 6–11 years were selected. All were apparently healthy.

After obtaining permission from School authorities, all the children studying in standard 1st to 4th (ages 6-11 years) were screened for weight, height and BMI was estimated. Weight was measured to the nearest 0.1 kg using electronic weighing scale with the child wearing only school uniform (without shoes). Height was measured to the nearest 0.1 cm using Stadiometer with the child standing on barefoot with head in Frankfurt plane position. Body Mass Index (BMI), which was defined as the ratio of body weight to body height squared, expressed in kg/m2. It was calculated for all children. Students were classified into four groups based on BMI percentiles specific to age and sex [6] as shown below

- **Thin:** BMI was less than or equal to 3rd percentile for that

age and sex.

- **Normal:** BMI was more than 3rd percentile but less than 85th percentile for that age and sex.
- **Overweight:** BMI exceeded 85 th percentile for that age and sex.
- **Obese:** BMI exceeded 95 th percentile for that age and sex.

The blood pressure was measured by auscultatory method using standard mercury sphygmo-manometer. Appropriate sized cuffs were used to measure blood pressure (BP). All observations were made on the right arm with child properly seated. The appearance of first Korotkoff sound and muffling of Korotkoff sounds were taken as systolic and diastolic pressure respectively. Two readings were taken at intervals of five minutes each and average of these two readings taken as systolic and diastolic blood pressure respectively.

All blood pressure recordings were taken on the same time of the day. Children were classified into the following groups as under [7].

- Normal (N) Blood pressure-BP < 90th percentile for that age, sex and height.
- Elevated blood pressure [Prehypertension] BP = 90-95th percentile for that age, sex and height.
- Hypertension (HTN) I-BP > 95th percentile for that age, sex and height.
- Hypertension (HTN) II-BP > 95th percentile + 12 mm of Hg.

Statistical analysis was carried out using SPSS version 21.0. Descriptive statistics such as means and standard deviation were used to summarize quantitative variable. Proportions and percentages were used to summarize categorical variables. Unpaired t test and Chi- square test were applied as test of significance and P value ≤0.05 was considered as statistically significant.

Results

A total of 388 children (boys: 216 and girls: 172) from two rural schools of Loni, Maharashtra were included in the study. They were in the age group of 6-11 years. Mean and standard deviations in anthropometric parameters, mSBP and mDBP in different age groups have been shown in Table 1. There was variability in mSBP as well as mDBP with increase in age.

Table 1: Age wise distribution of Weight, Height, BMI, mSBP and mDBP in study subjects

Age group	n	Weight (Mean ± SD)	Height (Mean ± SD)	BMI (Mean ± SD)	SBP (Mean ± SD)	DBP (Mean ± SD)
6-7	51	18.82 ± 3.27	111.3 ± 8.63	15.37 ± 3.39	93.92 ± 7.15	59.29 ± 5.98
7-8	92	20.73 ± 4.26	116.75 ± 9.83	15.39 ± 3.43	93.37 ± 10.43	62.33 ± 7.7
8-9	109	22.87 ± 3.93	124.5 ± 6.67	14.7 ± 1.98	95.79 ± 9.31	61.44 ± 8.0
9-10	98	24.71 ± 4.6	128.4 ± 8.32	15.01 ± 2.65	96.52 ± 12.16	65.58 ± 9.58
10-11	38	28.95 ± 5.7	136.84 ± 17.6	15.96 ± 2.47	97.74 ± 12.27	66.89 ± 8.9

mSBP and mDBP in various BMI categories has been shown in Table 2. There was consistent increase in mSBP and mDBP with increase in BMI status of boys and in mDBP of girls. However, there was variability in mSBP as far as girls were concerned.

Table 2

BMI		N	> 85	N	50-85	N	50-3	n	<3
Boys	mSBP	43	101.6 ± 11.74	23	96.78 ± 13	136	93.75 ± 9.49	14	89.64 ± 9.08
	mDBP		67.27 ± 9.37		66.87 ± 7.81		63.30 ± 6.45		63.21 ± 8.64
Girls	mSBP	24	104.58± 9.77	19	93.58 ± 10.86	114	95.4 ± 8.9	15	92.67 ± 6.17
	mDBP		65.92 ± 7.79		60.42 ± 8.39		60.3 ± 6.65		57.60 ± 5.71
Total	mSBP	67	102.67±11.1	42	95.34 ±12.04	250	94.5 ± 9.24	29	91.2 ± 7.72
	mDBP		66.77 ± 8.8		63.95 ±8.61		61.9 ± 6.7		60.31± 7.69

Prevalence of Elevated blood pressure and hypertension has been depicted in Table 3. Age, gender and type of school have been compared with the prevalence of Elevated blood pressure and hypertension.

Table 3

Age group	Sex	n	Private School (n=191)			Govt. School (n=197)			Total (n=388)			
			Elevated BP	HT	Combined	Elevated BP	HT	Combined	Elevated BP		Hypertension	
			n	n		n	n		n	%	n	%
6-7	Boys	22			0		1	1	0	-----	1	4.55
	Girls	29			0			0	0	-----	0	-----
7-8	Boys	58	3	1	4	1	1	2	4	6.9	2	3.45
	Girls	34		1	1		1	1	0	-----	2	5.88
8-9	Boys	44		2	2	1		1	1	2.27	2	4.55
	Girls	65	1		1		1	1	1	1.54	1	1.54
9-10	Boys	62	2	3	5		3	3	2	3.23	6	9.68
	Girls	36		3	3		3	3	0	-----	6	16.67
10-11	Boys	30	3	2	5	1		1	4	13.34	2	6.67
	Girls	08			0	1		1	1	12.5	0	-----
		388	9	12	21(11%)	4	10	14(7.1%)	13	3..35	22	5.67

Discussion

Childhood overweight and elevated blood pressure is a contributor to all forms of cardiovascular diseases. It has been demonstrated by various studies on Indian school children that the prevalence of hypertension (HTN) in overweight children is significantly higher than normal weight children. Studies on hypertension in childhood have an important advantage that they may help in the control and possibly prevention of high blood pressure before its harmful sequel can occur.

This study was a school-based study and it included the students of one Government and one Private school located in Western Maharashtra, India.

In the present study, mean weight, and height of boys were 23.6 ± 5.16 kg and 123.4 ± 1.2 cm, while that of girls were 22 ± 4.91 kg and 122.3 ± 0.08 cm, respectively.

The mean BMI of boys was 15.56 ± 3.07 kg/m2 and that of girls was 14.63 ± 2.33 Kg/m2. Difference in BMI between boys and girls was statistically significant. However, after 10 years of age girls were heavier than boys. Higher BMI values in children in similar age groups has been reported. [8] These differences in BMI can be attributed to socioeconomic and environmental differences.

In our study, mSBP in boys was 95.32 ± 10.74 mmHg, and that of girls was 95.49 ± 9.33 mmHg. There was no significant difference in mSBP between boys and girls. On the other hand, mDBP was statistically significantly higher in boys (64 ± 7.3 mmHg) in comparison to that of girls (61 ± 6.9 mm Hg).

In the present study 7.63% students had BMI percentile < 3 and 75.25 % were having normal BMI. 8.5% students were overweight and 8.76% were obese. Combined prevalence of overweight and obesity was more in boys (19.9%) than girls (13.95%), but the difference was not significant.

In this study, it was found that overweight and obese subjects both boys and girls had higher BP (both mSBP and mDBP) in comparison to normal weight children. The findings of this study were similar to the data in standard guidelines of updated 4th report for screening and management of high BP in children and adolescents [9].

There was weakly positive correlation between BMI with mSBP and mDBP in boys and in girls. Many researchers have reported the positive linear relationship between BMI and mSBP/DBP [10, 11].

With increase in BMI to significant proportion; blood pressure both systolic and diastolic increases to significant levels irrespective of age, sex. This was possibly due to differences in sympathetic tone between normal-weight and overweight subjects.

None of the underweight students had HTN. Obesity plays a major role in development of childhood HTN. However, in a study by Sharma A et al., the authors did not find any association between obesity and HTN [12].

As shown in Table-4, the prevalence of elevated blood pressure (pre-hypertension) and hypertension from different parts of India vary widely.

Table 4: Different Studies Demonstrating Prevalence of Elevated Blood Pressure (Pre-HT) and Hypertension.

Authors	Year	Age group Years	Prevalence		Location
			Pre-HT	Hypertension	
Kamble MB et al [13]	2019	6-12	1.47 %	4.49 %	Urban & Rural (Maharashtra)
Das MK et al [14]	2017	5-10	13.4 %	19.7%	Urban (Haryana)
Naha NK et al [15]	2016	5-10	5.8 %	4.5 %	Peri-urban (Kerala)
Madhivanan S et al [16]	2017	6-12	------	8.29 %	Urban (Tamilnadu)
Jena SK et al [17]	2016	6-12	------	6.45 %	Peri-urban (Odisha)
Sudhakar C et al [18]	2017	5-14	1.11 %	1.11 %	Rural (Chhattisgarh)
Present study	2019	6-11	3.35 %	5.67 %	Rural (Maharashtra)

The difference in prevalence of pre-HT/HTN reported earlier could be attributed to varying unidentified genetic, socio-economic, climatic, cultural and dietary factors. This may be due to the different criteria adopted for defining hypertension, methodology used, population sample and the variation in real prevalence.

Combined prevalence of elevated blood pressure and hypertension was observed to be more in children studying in Private school compared to Govt. school children, but the difference between them was not statistically significant.

Combined prevalence of Elevated blood pressure and hypertension was observed to be more in boys (11.11%) compared to girls (6.39%), but the difference between them was not statistically significant. However, prevalence of pre-hypertension was significantly more in boys (5.1%) than in girls (1.16%). In a study by Anjana et al, the prevalence of hypertension was 7.50% and 6.52% in males and females respectively [19].

Combined prevalence of pre-HT and HTN was 35.3% amongst obese children, 24.24% in overweight children as against only 5.14 % in normal weight children.

Age wise, prevalence of elevated blood pressure was maximum in children in age group of 10 + years, with more boys than girls being affected. However, the prevalence of hypertension was maximum in children in age group of 9-10 years, with more girls being affected. It is probably related to increase in BMI with onset of puberty especially in girls. Similar observation has been reported by Mahyar *et al*. [20] However, this finding contradicts the finding of Chiolero *et al*. where higher prevalence of HT was found among younger children [21].

This study indicates the high prevalence of hypertension in children of 6-11 years in rural Maharashtra. The recent rise in prevalence especially in low-income population may be due to the epidemiological transition over the years with change in the lifestyle and BMI status of the population. This transition in lifestyle may be due to the rapid urbanization influencing the dietary habits, physical activity status and social pressures.

With increase in age and BMI status, the prevalence of elevated blood pressure/hypertension increased in both sexes. It was interesting to note that a sizable proportion of normal-weight children had hypertension. Therefore, it mandates at

least annual blood pressure measurement along with anthropometric parameters for children in age group of 6-11 years during routine pediatric clinical practice and school health check-up.

Conclusion

In our study, the prevalence of obesity and overweight was 8.76% in 8.5%, respectively, and that of elevated blood pressure (pre-HT) and hypertension was 3.35% and 5.67 %, respectively. Prevalence of elevated blood pressure was more in private school children. BMI had very weakly positive correlation with rise in mSBP and mDBP. The association between overweight/obesity and elevated BP in children would reflect on an increased burden of hypertension-related diseases as the obesity epidemic further goes up even in rural or low-income population. This study reemphasizes the need to include blood pressure recording along with anthropometric measurements in school health program.

Limitations

As this is a cross sectional study, blood pressure was measured only twice in 5 minutes 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.

For the evaluation of prevalence, a larger group of students will be more appropriate. Socioeconomic status of the parents and dietary habit of the students are lacking here which are contributory factors for overweight/obesity and elevated blood pressure.

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Conflicts of Interest

There are no conflicts of interest.

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