

## Original Research Article

# Blood pressure distribution in relation with age, anthropometric measurements and socio economic status among school children of Warangal city, Telangana, India

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## ABSTRACT

**Background:** Hypertension is the one major global burden disease, causes 7.5 million deaths i.e.12.8%. Coronary Heart Disease Prevails 3-4% rural and 8-10% of urban population under 20 year's age in India. Two fold rise in rural & six fold rise in urban areas since four decades. Environmental and Genetic factors i.e. Sex, BSA, obesity, family history of hypertension, dietary habits, physical activity, stress, race, ethnicity and socio economic status influence on children and adolescent. Many studies have established normal standards of BP for the children of different ages and races in their countries. Indian children cannot be adopted due to differences in ethnic, socio-economic, dietetic, environmental and emotional factors.

**Methods:** A cross sectional study done with 2422 children of 5 to 16 years age school children, selected from 13 Schools (Government and Private) of Urban and Rural areas of Warangal.

**Results:** A linear increase in mean BP with age, sex, weight, height, social status and locality. DBP has strong negative correlation with sex. i.e. female have high DBP and children of lower class and rural area has high DBP. 54 children <85th and 95th percentile and 5 children >95th percentile has comparatively high mean BP, 27 children with history of Hypertension in parents are >85th and 95th percentiles. Positive correlation with BMI in both sexes studied. A multivariate regression study confers positive strong correlation of Mean SBP and DBP with anthropometry.

**Conclusions:** Observed similar results of SBP and DBP in both sexes, linear Increase in mean SBP and DBP with increasing age, weight, height and BMI. Family history of hypertension and high SES had direct correlation to SBP and DBP; class I SES has higher Mean SBP than class III SES.

**Keywords:** Body mass index, Body surface area, School children, Systolic blood pressure, Diastolic blood pressure, Socioeconomic status

## INTRODUCTION

Hypertension is one of the major diseases; prevalence is 1-2% in the developed countries and causing morbidities and 12.8% deaths worldwide. It is a major Condition in childhood and most common is essential type, it is confined to large metropolitan cities as Coronary Heart Disease more in urban population in Indian over 20 years age.<sup>1</sup> There is rising trend and is penetrating in small

cities of India undergoing Nutritional transition. Which constitutes two-fold rise in rural and six-fold rise in urban areas since four decades.<sup>2</sup>

Modifiable factors like Sex, Body size, obesity, family history of hypertension, altered dietary habits, physical activity, race, ethnicity and socio-economic status has direct influence on hypertension among children and adolescent.<sup>2</sup>

Many countries studied and established normal standards of Blood pressure for their children in different sexes and races.<sup>2</sup> It can't be imposed on Indian children due to differences in ethnic, socio-economic, dietetic, environmental and emotional factors. No such reliable statistics are available in India. It is mandatory to establish routine annual physical examination over 3 years of age for early detection and blood pressure standards for Indian children.<sup>3</sup>

Overweight and obesity are now on rising trends in low and middle-income countries, particularly in urban settings. The prevalence of overweight and obesity jeopardising insulin resistance along with rise in blood pressure concomitantly in children. 43 million children are overweight under 5 years age as reported by WHO in 2010.<sup>4</sup>

Therefore this study was done with following objective, to evaluate the blood pressure of school going children in the age group of 5-16 years of Warangal (Telangana) and to tabulate Percentile distribution.

## METHODS

This cross sectional study conducted in the Warangal city from July 2018 to September 2018 in 2422 school children of 5 to 16 years aged from 13 schools (Government and Private) selected by simple random sampling method from the provided list. Institutional ethical committee's clearance approved before the start of the study and permission accorded from school authorities.

Apparently healthy and asymptomatic School children have included, Children below 5 years and above 16 years and with known Cardiovascular, Renal and Endocrine Diseases have excluded from this study. Age of the school children was obtained from the school records; name and general information were entered in a pretested Performa after taking consent from parents.

Height was measured by using sliding stadiometer (Johnson and Johnson) with an accuracy of 0.1 mm. Weight was recorded using a spring balance (bathroom scale) calibrated to 0.5 Kg accuracy. BMI for boys and girls was calculated by using formula  $BMI = \text{weight (kg)} / \text{height}^2 \text{ (meters)}$  according to WHO.

Before recording the blood pressure, children were taken to a separate room away from noise and explained in detail the procedure of blood pressure recording and all efforts made to eliminate factors which might affect the blood pressure in order to record blood pressure at basal or near basal conditions.<sup>5</sup>

Blood pressure recordings were expressed to the nearest 10 mm Hg. Two blood pressure recordings were taken from each child at 0 and 2 minutes using auscultatory method. Average of two readings taken as blood pressure

of the individuals. All blood pressure recordings were taken on the same time of the day, i.e. during Interval hours and recorded by the same person and by same instrument.

The distribution of blood pressure by anthropometric characteristics like age, sex, height, weight, BMI, family history of hypertension and socio-economic status were studied.

## Statistical analysis

All results were tabulated and analyzed using IBM SPSS software Version 17.0. Chi square test was done for statistical significance. Mean and standard deviation were calculated for categorical data. Data analysed using ANOVA. Charts were prepared from Microsoft Excel 2007 Version.

## RESULTS

Out of 2422 children Boys were 1234 (50.87%) and Girls 1190 (49.13%) with a Male to Female Ratio of 1.035: 0.965. children of all age groups sex ratio approximately equally maintained except in 10 years, 11 years and 12 years. p Value of sex distribution is 0.414 which is significant for study.

There is linear increase of Mean Blood Pressure with Increasing Age and Mean SBP of Study group was 97.78 and DBP was 62.46 mm of Hg. The Mean SBP in Boys at 5 years is 79.55 mm of Hg and at 16 years is 113.39 mm of Hg and the Mean SBP in Girls at 5 Years is 81.37 and at 16 years 106.71 mm of Hg (Table 1).

The Mean DBP in boys at 5 years is 48.3 mm of Hg and at 16 years 67.39 mm of Hg. There is linear increase in Diastolic BP from 5 years to 13 years, slight spurt in DBP noted at 12 years and 16 years age.

**Table 1: Age wise SBP and DBP boys and girls.**

Age group (Year)	Sample Size		Mean Systolic BP (mm of Hg)		Mean Diastolic BP (mm of Hg)	
	Girls	Boys	Girls	Boys	Girls	Boys
5	35	38	81.37	79.55	53.89	48.3
6	64	65	83.05	86.32	51.95	56.53
7	84	71	88.02	88.8	55.32	58.72
8	81	76	91.62	92.03	60.64	57.06
9	95	84	95.96	95.61	63.69	62.62
10	124	102	97.02	98.04	63.6	62.83
11	152	185	99.17	100.02	64.65	65.01
12	140	192	103.42	103.65	65.75	68.05
13	148	153	104.3	105.62	65.5	66.63
14	128	134	107.12	109.4	68.47	67.9
15	113	97	106.46	109.42	67.23	69
16	26	35	106.71	113.39	68.41	67.39
	2422		97.78		62.46	

The Mean SBP in Boys at 5 years is 79.55 mm of Hg and at 16 years is 113.39 mm of Hg and the Mean SBP in Girls at 5 years is 81.37 and at 16 years 106.71 mm of Hg.

The Mean SBP in Girls at 5 years is 81.37 mm of Hg and at 16 years is 106.71 mm of Hg and the Mean DBP in girls at 5 years is 53.89 mm of Hg and at 16 years 68.41 mm of Hg. There is linear Increase in Diastolic BP with Age, except at 6 years where it is disproportionately lower (Table 1). Similar study of Anand NK et al, and

Raj et al, confirms direct proportional relation of Mean BP to the increase in age.<sup>6,7</sup>

It was observed that a linear increase in Mean Systolic and Diastolic Blood pressures as the height increased with a steep rise in >160 cms height group (Table 2).

Narang et al, observed positive effect on SBP and DBP in relation to height and Raj et al, revealed relatively significant correlation for both systolic and diastolic blood pressures with height.<sup>7,8</sup>

**Table 2: Distribution of SBP and DBP with relation to height in boys and girls.**

Height in (cm)	Overall			Boys			Girls		
	Sample Size	SBP±SD	DBP±SD	Sample Size	SBP±SD	DBP±SD	Sample Size	SBP±SD	DBP±SD
100-110	102	83.4±2.07	53.28±0.21	50	82.6±3.72	52.33±2.10	52	84.22±0.35	54.34±2.60
111-120	242	87.12±2.82	55.18±0.84	120	86.68±2.68	54.80±0.14	102	87.56 ±3.06	57.14±3.74
121-130	328	92.88±1.74	60.58±1.04	161	93.69±1.89	60.37±0.17	167	92.09±1.44	60.90±2.25
131-140	446	98.41±3.22	63.63±2.55	250	98.63±3.27	63.80±3.16	196	98.13±3.18	63.42±1.78
141-150	562	102.38±0.28	66.10±0.46	163	103±0.38	67.11±1.49	299	101.78	65.04±0.72
151-160	517	105.8±1.59	67.09±1.14	214	106.4±1.35	66.89±0.93	303	105.3±1.61	67.26±1.37
161-170	177	111.02±0.25	69.59±0.44	129	111.33	69.1±0.19	48	110.17±0.58	71.32±1.85
171-180	48	112.54±0.28	72.92±2.46	45	112.53±0.26	72.88±2.52	3	111.83	72.17

**Table 3: Distribution of SBP and DBP with relation to weight in boys and girls.**

Weight in (kg)	Overall			Boys			Girls		
	Sample Size	SBP±SD	DBP±SD	Sample Size	SBP±SD	DBP±SD	Sample Size	SBP±SD	DBP±SD
10-20	293	82.84±4.58	51.8±5.10	143	82.96±3.62	51.83±4.32	150	82.85±5.38	51.84±5.77
21-30	760	95.6±2.87	61.96±2.94	404	96.35±3.03	62.38±3.10	356	94.75±2.71	61.47±2.75
31-40	692	101.1±1.30	64.85±1.09	361	102.42±2.40	65.75±0.21	331	99.65±0.21	63.69±2.12
41-50	471	107.3±3.67	67.69±1.81	212	107.85±3.04	66.61±1.26	259	106.9±4.12	68.61±2.40
51-60	152	112.19±2.16	71.49±2.87	76	113.25±2.74	73.15±1.42	76	111.64±4.29	70.03±3.59
61-70	36	117.39±0.68	73.89±4.99	23	118.48±2.37	72.61±638	13	119.8±3.46	77±1.41
71-80	14	118.62±2.65	79.79±3.59	9	121.74±7.65	78.41±7.19	5	115.9±2.94	85.08±5.53
81-90	4	125±1.41	82.5±13.43	3	132±11.31	88.5±4.94	1	112	62
Total	2422	107.5	69.24	1231	109.14	69.91	1191	105	67.48

There is linear increase of mean systolic and diastolic blood pressures in both sexes, No significant difference between Boys and Girls was observed (Table 3). Agarwal VK et al, found to have direct correlation with Weight.<sup>9</sup>

Out of 2422 children, 54 children fall under 85<sup>th</sup> and 95<sup>th</sup> percentile and 5 children >95<sup>th</sup> percentile in those SBP and DBP also significantly higher than other BMI groups. There is linear relationship between SBP and DBP with increasing BMI (Table 4).

Taksande A et al, established significant correlation of SBP and DBP with the weight and BMI. Verma M et al, also observed statistically significant linear relationship

between blood pressure and weight.<sup>10,11</sup>

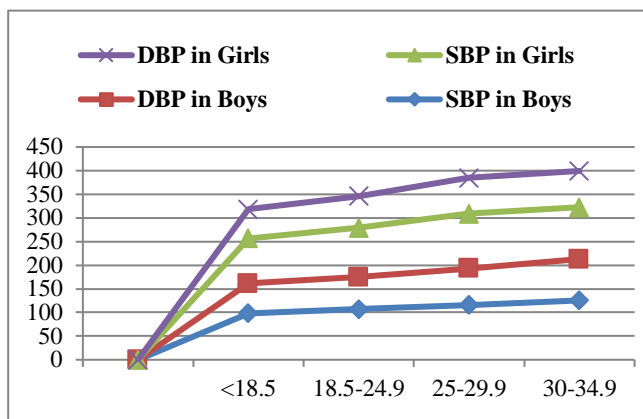
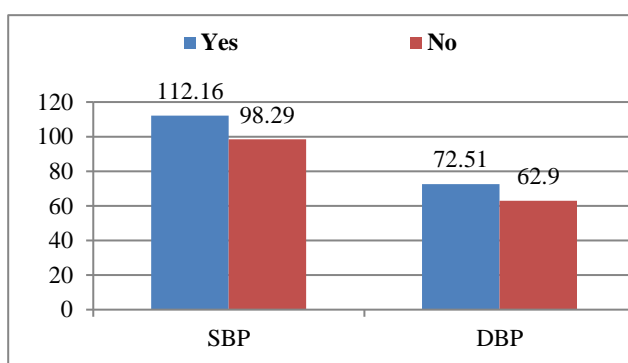
Durrani AM et al, and Singhal V et al, concluded positive correlation of mean SBP and DBP with anthropometric parameters higher in the age group of 12-16 years.

Verma V et al, also observed similar to this result. Shanna LD et al, studied and calculated Mean systolic and diastolic blood pressure with standard deviation in relation to anthropometry and 95<sup>th</sup> percentiles for each age group were calculated.<sup>12-14</sup>

Depicts SBP and DBP has positive correlation with BMI equal in both sex (Figure 1).

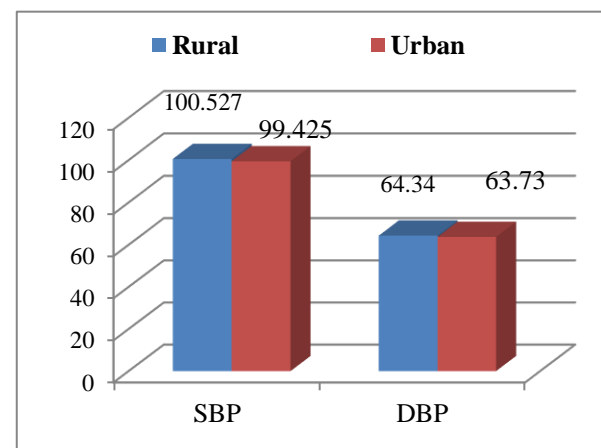
**Table 4: Mean and SD of SBP and DBP in relation with BMI in boys and girls.**

BOYS					GIRLS			
Age (Year)	Sample Size	BMI±SD	Systolic BP±SD	Diastolic BP±SD	Sample Size	BMI±SD	Systolic BP±SD	Diastolic BP±SD
5	38	15.18±2.53	79.55±7.62	48.3±9.13	35	15.54±3.2	81.37±8.42	53.89±10.72
6	65	15.84±2.67	86.32±8.63	56.53±10.3	64	15.14±2.55	83.05±9.77	51.95±9.36
7	71	15.15±2.64	88.8±8.36	58.72±9.09	84	14.17±2.58	88.02±8.73	55.32±8.71
8	76	15.45±2.73	92.03±9.22	57.06±8.48	81	15.08±2.63	91.62±10.1	60.64±10.25
9	84	15.84±2.94	95.61±10.71	62.62±11.18	95	15.83±2.82	95.96±9.99	63.69±9.69
10	102	16.27±3.10	98.04±9.89	62.83±11.07	124	15.95±3.06	97.02±13.59	63.6±9.29
11	185	16.73±2.65	100.02±10.10	65.01±10.20	152	17.2±3.23	99.17±10.74	64.65±10.17
12	192	16.51±2.90	103.6±10.67	68.05±10.15	140	17.49±3.13	103.42±10.48	65.75±9.83
13	153	17.64±3.13	105.6±9.5	66.63±11.07	148	18.11±3.27	104.3±10.83	65.5±10.38
14	134	18.1±3.36	109.4±10.90	67.9±11.58	128	19.28±3.27	107.12±10.41	68.47±10.13
15	97	18.16±3.13	109.4±9.95	69.0±11.13	113	19.32±3.10	106.46±11.04	67.23±9.86
16	35	17.67±3.43	113.3±10.85	67.39±11.12	26	19.79±3.67	106.71±12.26	68.41±11.56

**Figure 1: Distribution of SBP and DBP with relation to BMI and its percentiles.****Figure 2: Distribution of SBP and DBP with history of HTN in parents.**

The mean SBP of children (i.e. 112.16 mm of Hg) with history of HTN in either parent was statistically higher than mean SBP of children (i.e. 98.29 mm of Hg) either of whose parents gave history of normotension. (p Value 0.00001; Z = 21.77).

Depicts that the children with family history of hypertension has higher mean SBP and DBP than those without family history (Figure 2).

**Figure 3: SBP and DBP in children with relation to locality.**

It was observed that Children with family history of Hypertension have higher Mean SBP and DBP than those without family History. Gupta AK also found similar with this study.<sup>16</sup>

The study population was classified into 5 social groups i.e. Upper, Upper Middle, Lower middle and Upper Low and Lower Low-Income groups according to Modified Kuppuswamy Scale (Education, Income and Occupation of Parents). The mean SBP in class I SES is 109.7 mm of Hg and class III SES is 96.95 mm of Hg, which is higher and statistically significant. (p Value 0.00001; Z = 22.16). However, 90% study population i.e. 2103 is in class II SES. Depicts SBP and DBP in children of rural and urban, as rural children were noticed high blood pressures than urban (Figure 3).

### Observations

- There is significant difference between means of 5, 10 and 15 years boys group SBP. F value is 121.55394, p value is 0.00001 and  $p < 0.05$ , hence  $H_0$  will be rejected.
- There is significant difference between means of 5, 10 and 15 years Boys group DBP. F value is 54.786, p value is 0.00001 and  $p < 0.05$ , hence  $H_0$  will be rejected.
- There is significant difference between means of 5, 10 and 15 years girls group SBP. F value is 61.203, p value is 0.00001 and  $p < 0.05$ , hence  $H_0$  will be rejected.
- There is significant difference between means of 5, 10 and 15 years girls group DBP. F value is 25.204, p value is 0.00001 and  $p < 0.05$ , hence  $H_0$  will be rejected.

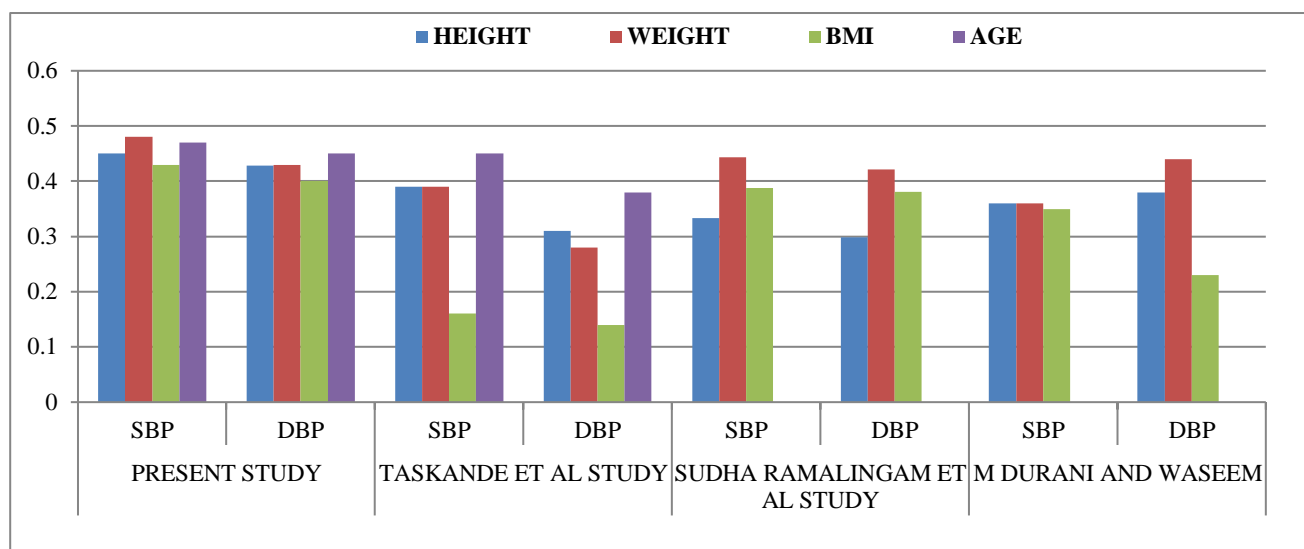
In this study age, sex, social status, BMI and locality has negative correlation with occurrence of systolic BP. Weight and height has positive correlation. Children of upper class of urban area SBP is low and of lower class

and rural area has higher DBP, Linear increase in SBP with increasing weight and height (Table 5).

**Table 5: Multi variate analysis of BP distribution in relation to anthropometry.**

Variables	Correlation r	Determination r <sup>2</sup>	Standard Error
BMI and SBP	0.42236	0.17838797	0.016687854
BMI and DBP	0.346	0.119716	0.017879547
Age and SBP	0.5815	0.33814225	0.013443067
Age and DBP	0.3878	0.15038884	0.017256547
Weight and SBP	0.6061	0.36735721	0.012849678
Weight and DBP	0.44581	0.198746556	0.016274348

Tested the significance of difference between means of SBP and DBP at 5 years, 10 years and 15 years by Using ANOVA.



**Figure 4: Comparison of Pearson's correlation coefficients of present study with other studies.**

Diastolic Blood pressure has strong negative correlation with sex. i.e. female have more diastolic compared to males. Narang et al, studied positive effect of age, height and weight on SBP and female gender were with higher SBP and DBP directly correlated with weight and waist circumference.<sup>8</sup>

Based on Pearson's Correlation coefficient, relation of SBP and DBP with anthropometric variables is significant ( $p$  Value  $< 0.01$ ). This is in concurrence with

Taksande et al, M. Durani and Wasim F and Ramalingam S et al.<sup>10,12,18</sup> (Figure 4).

### DISCUSSION

#### Age and its relation to blood pressure

Age distribution of children in this study is 5-16 years. The study revealed a linear increase of blood pressure with increasing age in both sexes.



**Height and its relation to blood pressure**

A linear increase in mean SBP and DBP noted with increasing height which is found to be statistically significant ( $P < 0.001$ ).

**Weight and its relation to blood pressure**

It was observed that systolic and diastolic blood pressure increased linearly with weight, and this increase is statistically significant ( $p < 0.001$ ). Gupta AK and Ahmed AJ proved positive Correlation with height and weight.<sup>19</sup>

**Body mass index and its relation to blood pressure**

BMI is used as an indicator of adipose deposition. They are usually defined using age and gender specific normograms of BMI. Both systolic and diastolic blood pressure were significantly ( $p < 0.001$ ) higher in over weight and obese group when compared to children with normal BMI. This indicates that BMI percentile can be used as predictor of high blood pressure. Nanaware NL et al, Chiolerio A et al, and Jasmine S Sundar et al, also found Strong positive correlation of BMI with both systolic and diastolic blood pressure.<sup>20-22</sup>

**Distribution of blood pressure according to socio economic status**

It was observed that the mean systolic and diastolic blood pressure increased linearly with High socio-economic status which could be because of higher mean weight in children with higher socioeconomic status. The p value is significant at ( $< 0.001$ ). Madhusudhan et al, study and Prasad S et al, study observed similar results, which has strong positive correlation in various socio-economic groups in relation to SBP and DBP.<sup>23,24</sup>

**Family history and its relation to blood pressure**

Various studies suggests that hypertension tends to aggregate in families and the cause can be genetic, environmental or both. In this study, 9.9% of children are having family history of hypertension. They have higher levels of blood pressure compared to children of normotensive parents. It was observed in both sexes and is statistically significant ( $p < 0.001$ ) which is in accordance with findings observed by Madhusudhan et al.<sup>24</sup>

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