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Original Research Article

A study of blood pressure in school children between the age of 6-12 years in Chennai, India: a cross sectional study

Madhivanan S., Harikrishnan E., Kumarasamy K.*

Department of Paediatrics, Government Villupuram Medical College, Villupuram, Tamil Nadu, India

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***Correspondence:**
Dr. Kumarasamy K.,
E-mail: prinita_pink@yahoo.co.in

ABSTRACT

Background: Blood pressure measurements in childhood are an important clinical examination. Present study was done to evaluate the normal range of blood pressure (BP) in children aged 6-12 years and to find its relationship with regard to age, sex, height and weight criteria and comparing the values with the available standards.
Methods: This prospective cross-sectional study was done in primary and middle schools of Chennai from January 2016 to May 2017. Three readings of blood pressure were recorded for each subject and were correlated with age, gender, socioeconomic status and anthropometry. Data was analysed on SPSS 20.0. P value of <0.05 was considered significant
Results: A total of 2002 children (1026 boys, 976 girls) of age between 6-12 years were examined over 18 months. There was an upward trend in both systolic (r = 0.437, P<0.001) and diastolic BP (r = 0.386, P <0.001) with age. There was no statistically significant difference in mean systolic and diastolic BP with gender (P = 0.10), weight (P = 0.10) and height (P = 0.10). There was a statistically significant difference between the mean systolic and diastolic BP between low and high socio-economic groups (P <0.0001). The proportion of children with hypertension was 9.54% with a slight female preponderance.
Conclusions: Blood pressure measurement in children is pivotal in clinical examination. It shows a linear relationship with age and varies across socio-economic status. Periodic recording of BP would enable identify hypertension at an early age.

Keywords: Blood Pressure, Diastolic BP, Hypertension, Systolic BP

INTRODUCTION

Blood pressure measurement in childhood is an important clinical examination. Blood pressure is an important physical sign as the body temperature, pulse rate and respiratory rate. But recording of blood pressure is often neglected in pediatric practice.

Recent emphasis on hypertension and its possible origin during childhood has served as an impetus for pediatrician to routinely include measurement of blood pressure as an integral part of pediatric physical examination.[1] In hospitalized patient, it is considered as an important and routine like documentation of body temperature, pulse rate and respiratory rate. In the office it is now common practice to measure and record the blood pressure in all children including new born.

Routine recording will become a very useful practice and help to make early diagnosis of many hypertensive problems like unsuspected coarctation of Aorta, renal disease etc. This is also important in view of the fact that almost all the cases of hypertension in infants and children, if diagnosed early are treatable and completely

curable because majority of these are clue to secondary hypertension.

Primary prevention of one of the leading health problems like hypertension and ischemic heart disease in adults necessitates a scientific evaluation of the predictors in children. Blood pressure studies in children provide important epidemiological information which may help in controlling or modifying the risk factors. The underlying process of growth and maturation is closely linked to the blood pressure in children. A number of socio-cultural factors also influence the blood pressure.

India is a vast country with divergent customs, dietary habits and socio-economic background. The data on blood pressure profile in Indian children is inadequate with few studies showing different patterns of normal blood pressure.

Londe S recorded blood pressure in 894 boys and 911 girls from the age of 4-15 years.[3] He reported that the mean systolic pressure in boys rises steadily from 98 mm of mercury at 4 years to 125 mm mercury at 15.

In girls, it rises from 98 mm mercury at age 4 to a highest value of 121 mm mercury at ages 11 and 13 years. There was no significant difference between the sexes except at the age 11 where it is 7 mm mercury higher for girls and at the age of 15 years it is 10 mm mercury higher for boys.

The mean diastolic pressure shows a very gradual rise for boys from 57 mm of mercury at age 4 to the highest value of 68 mm of mercury at age.[14] He reported that 111 boys (12.4%) and 106 girls (11.6%) had blood pressure above the 90th percentile.

35 children - 14 boys and 21 girls had abnormally high blood pressure, pressure above 75th percentile.

Kaplan and Lyons state that blood pressure in children is closely related to weight and height.[4]

The data of Stocks and Karns from a study on boys indicated a relation between systolic pressure with weight and height and for diastolic pressure with height only in the age group of 9-15 years.[5]

Richeys showed a significant relation between systolic and diastolic pressure with weight and of diastolic with height for girls.[6] Systolic pressure was related to height in 11 through 15-year-old girls.

Hahn studying boys from 11 through 15 years of age, reported significant correlation of blood pressure with weight and height in each year.[7]

Second task force on blood pressure control in children8 reports approximately 5% of children fall beyond 95th percentile for systolic and diastolic blood pressure. On reexamination, only 1% of the original group had persistently elevated systolic and diastolic blood pressure.

Chahar CK et al studied blood pressure in 500 children (both boys and girls) from 2 schools of Bikaner between the age groups 4-9 years.[9]

There was a gradual rise in systolic blood pressure of males with age. However, diastolic blood pressure was more in the age group of 4 years. Then became relatively low till the age of 5½ years, followed by a gradual rise till the age of 9 years. Prevalence of hypertension was 1.39%.

Agarwal VK et al studied blood pressure in 2645 children between 3-15 years of age.[10] Both systolic and diastolic blood pressure were found to have direct correlation with Weight but not with height.

No significant difference between males and females was observed. Overall incidence of hypertension was 1.8%; of this 0.52% were systolic hypertension; 0.52% were diastolic hypertension; In 0.76% cases both systolic and diastolic blood pressure were raised.

Shanna LD et al examined 2073 school children between the age groups of 5-14 years.[11] An equal number of children in each age, sex and socio-economic groups were studied. Mean figures for systolic and diastolic blood pressure with standard deviation and 95th percentiles for each age group were calculated.

Systolic and diastolic blood pressure for both sexes had a direct correlation with age, weight and height; overall prevalence of hypertension was found to be 2.93%.

Gupta AK and Ahamed AJ studied 3861 school children in the age group 5-15 years.[12] They reported that the systolic and diastolic pressure showed a positive correlation with height and weight. 255 children (6.60%) had blood pressure in excess of +2 SD. of the mean for age and sex on first contact. On reevaluation only 16 (0.41%) had sustained blood pressure more than +2 SD.

Gupta AK studied blood pressure levels of 3194 children in the age group 5-15 years.[13] He reported that subjects coming from families with history of hypertension (with myocardial infarction, stroke etc.) tended to have significantly higher values of both systolic and diastolic pressure in both the sexes in all age groups studied.

On the contrary only one (0.03%) of the 2884 children belonging to normal parents had persistent hypertension.

Venna M et al evaluated blood pressure in 2560 school children between the ages of 5-15 years in Punjab.[14] He reported that systolic and diastolic blood pressure increased with age in both sexes and the correlation coefficient are 0.59 and 0.6 respectively.

A statistically significant linear relationship between blood pressure and weight was noted. Children with body mass index >2.26 had a significantly higher blood pressure (P <0.01). He also reported that obesity and family history of hypertension in children are associated with elevated blood pressure.

Anand NK et al studied blood pressure in 5000 school children of Amritsar city in the age group between 5-17 years.[15] He reported that the rise in blood pressure was directly proportional to the increase in age and there was no significant difference between the systolic blood pressure and diastolic blood pressure of 2 sexes at various age groups. He reported that hypertension was observed only in 0.46% children and obesity and family history of hypertension were found to be important influencing factors in the development of hypertension.

So the present study was aimed at finding the normal range of blood pressure in school children aged 6-l2 years, and the relationship of blood pressure with variables like age, height, weight, socio economic status and obesity and also to identify the cut off point for hypertension and prevalence of hypertension in school children.

METHODS

The prospective cross-sectional study was conducted in Primary schools, middle schools that belong to the corporation of Chennai and also in private school located in the same locality.

The study was done for a period of 17 months from January 2016 to May 2017.

2002 children were randomly selected of which 110 are from corporation schools and 902 were from private school. All children were subjected to thorough clinical examination to rule out pathological conditions that are associated with hypertension.

The blood pressure was measured in measured by auscultatory method using standard mercury sphygmomanometer. Seven and twelve cm wide cuffs were used depending on width most closely approximated to two thirds of the arm. All observations are made on the right arm with child properly seated.

In all cases brachial artery was routinely felt. Only after palpation of brachial artery the right upper limb was used for recording blood pressure as it is a direct continuation from the ascending aorta. Femoral artery was felt routinely to rule out any congenital lesion like coarctation of aorta. These group of children were very cooperative and technically also feasible to hear the Korotkoff sounds well.

The appearance of first Korotkoff sound and muffling of Korotkoff sounds were taken as systolic and diastolic pressure respectively. Three readings were taken at interval of five minutes each and average of these three readings taken as systolic and diastolic blood pressure respectively. The blood pressure levels were checked by another examiner to rule out intra-observer variations. Only after alleviating the anxiety and explaining the procedure the blood pressure was recorded.

Socioeconomic status was assessed on the basis of socio-economic status scale by Kuppuswamy.

Values more than +2 SD above the mean systolic pressure and mean diastolic pressure were taken as the cut off values for hypertension and children with blood pressures more than +2SD were referred to Institute of Child Health and Hospital for Children, Egmore for further evaluation.

To assess the correlation of obesity and elevated blood pressure, Body Mass Index (BMI) was calculated for all children. Children with BMI >2.26 were classified as obese.

Inclusion criteria

All school children in the age groups of 6-12 years where the study was conducted.

Exclusion criteria

Children with renal diseases and cardiac diseases and pathological conditions that affect blood pressure are excluded.

Statistical analysis

Data was analysed using SPSS version 20.0.

RESULTS

A total number of 2002 children were examined, of which 1026 were boys and 976 were girl (Table 1). With respect to socio economic class 902 children were from high socio-economic group and 1100 were from low socio-economic group.

Table 1: Age and sex distribution of children.

Age	Male	Female	Total
6 years	156	158	314
7 years	143	126	269
8 years	145	154	299
9 years	139	132	271
10 years	139	126	265
11 years	151	134	285
12 years	153	146	299
Total	1026	976	2002

There was a rise in both systolic and diastolic blood pressure which was also directly proportional with respect to age and it was statistically significant. Mean systolic pressure in boys rose steadily from 86.35 mm Hg at 6 years of age to 97.94 mm Hg at 12 years of age. Whereas in girls mean systolic pressure rose from 86.10 mm Hg at 6 years to the highest value of 100.89 mm Hg at 12 years (Table 2). There was no statistically significant difference in the mean value of systolic pressure between 2 sexes (P >0.10) except for the significant difference (P <0.01) at age 12 years where it is 3mm mercury higher for the girls.

Table 2: Mean and +2 SD for systolic blood pressure according to age and sex.

Age (year)	Male			Female		
	No.	Mean	+2SD	No.	Mean	+2SD
6	156	86.35	101.93	158	86.10	101.74
7	143	90.36	106.86	126	90.03	101.85
8	145	91.61	107.71	154	92.69	107.19
9	139	92.99	106.85	132	92.94	107.44
10	139	93.64	111.96	126	92.70	112.0
11	151	96.44	111.34	134	96.25	113.43
12	153	97.94	114.90	146	100.89	121.81

A spurt in systolic pressure was noted between 6 and 7 years in both sexes and between 11 and 12 years in girls. Between 8 and 10 years, it is steadily maintained around 92 mm of Hg whereas there was a steady increase noticed in boys. The mean diastolic pressure in boys increased from 52.56 mm Hg at the age of 6 years to 60.98 mm Hg at 12 years with an increase in spurt of 4.16 mm Hg between 6-7 years. But in girls, mean diastolic pressure increased from 51.74mm Hg at 6 years to 63.23mm Hg at 12 years with a spurt of 4.15 mm Hg between 6 and 7 years and 3.41 mm Hg between 7 and 8 years (Table 3).

Table 3: Mean and +2 SD for diastolic blood pressure according to age and sex.

Age (years)	Male			Female		
	No.	Mean	+2SD	No.	Mean	+2SD
6	156	52.36	66.50	158	51.74	66.78
7	143	56.20	69.38	126	55.89	65.71
8	145	56.97	71.87	154	59.31	72.81
9	139	59.58	74.06	132	59.40	71.28
10	139	59.07	75.31	126	58.90	71.96
11	151	61.10	76.80	134	61.26	78.42
12	153	60.98	75.92	146	63.23	79.41

There was no statistically significant difference in the mean value of diastolic pressure between 2 sexes (P >0.10) except at the age of 8 years and 12 years where it was higher by 3mm Hg in girls. There was a significant effect of socio-economic status on blood pressure noticed in this study.

Table 4: Mean and standard deviation for systolic blood pressure according to age and sex for children from high socio-economic status.

Age (years)	Male			Female		
	No.	Mean	+2SD	No.	Mean	+2SD
6	55	90.62	8.53	61	88.62	9.36
7	65	92.43	9.04	53	93.89	5.6
8	71	94.68	8.15	53	96.37	6.88
9	69	94.23	6.50	59	93.19	5.33
10	72	94.58	10.88	50	93.64	8.55
11	85	96.87	6.77	60	98.00	9.76
12	84	100.10	9.50	65	102.12	9.57

Table 5: Mean and standard deviation for systolic blood pressure according to age and sex for children from high socio-economic status.

Age (years)	Male			Female		
	No.	Mean	+2SD	No.	Mean	+2SD
6	55	57.27	7.61	61	55.02	8.67
7	65	58.98	6.66	53	61.96	5.26
8	71	61.13	9.23	53	63.96	6.86
9	69	62.96	7.78	59	63.02	5.72
10	72	60.94	7.76	50	60.28	5.87
11	85	63.84	7.06	60	63.97	8.16
12	84	63.24	7.81	65	65.97	7.18

Table 6: Mean and standard deviation for systolic blood pressure according to age and sex for children from high socio-economic status.

Age (years)	Male			Female		
	No.	Mean	+2SD	No.	Mean	+2SD
6	101	82.08	7.04	97	83.57	6.27
7	78	88.28	7.45	73	86.16	5.95
8	74	88.54	7.94	101	89.01	7.62
9	70	91.74	7.35	73	92.69	9.16
10	67	92.69	7.43	76	91.76	10.75
11	66	96.00	8.12	74	94.49	7.41
12	69	95.77	7.46	81	99.65	11.34

Table 7: Mean and standard deviation for systolic blood pressure according to age and sex for children from high socio-economic status.

Age (years)	Male			Female		
	No.	Mean	+2SD	No.	Mean	+2SD
6	101	47.45	6.53	97	48.46	6.37
7	78	53.41	6.52	73	49.81	4.55
8	74	52.81	5.66	101	54.65	6.64
9	70	56.20	6.69	73	55.77	6.15
10	67	57.19	8.48	76	57.52	7.18
11	66	58.36	8.63	74	58.54	8.99
12	69	58.72	7.12	81	60.48	8.99

Both mean systolic and mean diastolic pressure were higher in high socio-economic group when compared to low socio-economic group in both sexes and there was highly significant difference in the mean values of systolic pressure, diastolic pressure between high and low Socio-economic group children (P<0.0001) (Table 4, 5, 6 and 7).

Table 8: Distribution of blood pressure according to weight.

Weight (kg)	Male			Female		
	No.	MSBP	MDBP	No.	MSBP	MDBP
10-15	62	80.03	47.77	35	82.29	49.20
16-20	269	87.84	53.67	298	86.77	83.20
21-25	264	91.39	57.39	254	91.74	58.03
26-30	197	95.25	60.29	157	95.26	59.95
31-35	154	98.05	61.84	152	97.47	60.95
36-40	45	101.42	65.47	51	106.51	67.29
41-45	20	105.40	67.80	17	104.75	68.13
46-50	8	112.25	70.25	8	110.50	68.50
51-55	6	116.33	72.67	3	116.67	73.33
56-60	1	120.00	78.00	1	114.00	80.00

(MSBP- Mean systolic blood pressure; MDBP Mean diastolic blood pressure)

Table 9: Distribution of blood pressure according to weight.

Weight (kg)	Male			Female		
	No.	MSBP	MDBP	No.	MSBP	MDBP
80-90	10	74.60	45.20	1	72.00	46.00
91-100	54	80.59	47.52	19	78.84	47.04
101-110	109	86.39	51.63	145	84.54	50.52
111-120	245	89.40	55.35	260	88.98	54.74
121-130	227	93.96	58.87	236	94.51	60.13
131-140	259	95.90	50.97	231	96.75	61.20
141-150	93	99.48	64.38	59	103.46	65.25
151-160	26	107.69	68.69	25	106.58	70.75
161-170	3	112.00	66.00	-	-	-

Table 10: Prevalence of hypertension.

Blood pressure	Male		Female		Total	
	No.	Prevalence %	No.	Prevalence %	No.	Prevalence %
Systolic	47	4.58	40	4.10	87	4.35
Diastolic	44	4.29	60	6.15	104	5.19
Both	20	1.95	14	1.43	34	1.70
Total	111		114		225	11.24

Table 11: Prevalence of hypertension in obese children.

Blood pressure	Male		Female		Total	
	No.	Prevalence %	No.	Prevalence %	No.	Prevalence %
Systolic	6	66.67	1	20.00	7	50.00
Diastolic	6	66.67	2	40.00	8	57.14
Both	5	55.56	1	20.00	6	42.86

We found that both mean systolic and mean diastolic blood pressure increased with increase in weight and height in both sexes (Table 8 and 9) and there was no statistically significant difference in the mean value of systolic and diastolic pressure with respect to height and weight between 2 sexes (P >0.10). Hypertension was observed in 157 children with prevalence of hypertension as 9.54% with a slight female preponderance (Table 10).

Only 14 children were obese in our study (9 boys and 5 girls). Among boys 6 (60.67%) had systolic hypertension, 6 (66.67%) had diastolic hypertension and 5 (55.56%) had both systolic and diastolic hypertension. Among girls 1 (20%) had systolic hypertension, 2 (40%) had diastolic hypertension and l (20%) had both systolic and diastolic hypertension (Table 11).

The prevalence of hypertension in obese children was 64.29% when compared to 7.19% in non-obese children. (Table 12).

Table 12: Prevalence of hypertension in obese and non-obese children.

Category	Number	With hypertension	Without hypertension	Prevalence %
Obese	14	9	5	64.29%
Non-obese	1988	157	1831	7.19%

DISCUSSION

The present study shows that the mean blood pressure of both systolic and diastolic shows an upward trend with increase of age. This upward trend with age correlates with the studies by other authors.[3,8-10]

The mean systolic blood pressure at the age of 6 years for males in this study is 86.35 mm Hg and that of western standard is 105 mm Hg which was also found by some Indian authors.[3,10,11]

The mean systolic and diastolic blood pressure were lower for all ages when compared to other studies.[3,8-10]

The findings of present study revealed that a spurt of about 4 mm Hg in systolic and diastolic blood pressure is observed from 6-7 years in both boys and girls. Similar spurt of 3 mm Hg is observed for systolic blood pressure between 10 and 11 years in boys and between 10 and 11 and 11 and 12 for girls.

A spurt of 3 mm Hg is observed for diastolic blood pressure for boys between 8 and 9 years and for girls between 7 and 8 years. Similar observations have been made by other investigators, who found a spurt of systolic blood pressure between 13 - 15 years age group.[3,10,13] The Task Force Committee reports found this spurt between 5-6 years in both the sexes.[8,16] The spurt may possibly be due to certain hormonal and physical changes occurring in the body. The mean diastolic blood pressure for male rises from 52.36 at the age of 6 years to 60.98 at l2 years of age. The mean diastolic blood pressure for female rises from 51.74 at 6 years of age to 63.23 at 12 years of age.

This is in correlation with the observation of Sachdev Y in which the mean diastolic pressure was 62.17 but when compared to the study of diastolic blood pressure at 12 years of age by Agarwal R, our readings are little lower.[18]

The average increment of systolic blood pressure and diastolic blood pressure from 6 years to 12 years is 2-3 mm Hg. This is in correlation with Agarwal R and others.[18] Haggerty did not observe any significant variation between 2 sexes both for systolic and diastolic blood pressure which is similar to the present study.[19] Londe S noted significant difference between the 2 sexes, 10 mm Hg higher in boys at the age of 15 years.[3]

The systolic blood pressure and diastolic blood pressure for girls is 3 mm higher at the age of l2 years when compared to boys. In other age groups it was almost closely parallel with each.

There is a highly statistically significant difference found in mean systolic pressure and mean diastolic pressure between 2 socioeconomic groups in the present study. This was not shown in earlier studies like Weiss et al[20] in their detailed study of blood pressure levels in children in relationship with the age, sex, race and socio-economic status and also by Londe.[3]

Both mean systolic pressure and mean diastolic pressure were lower in boys and girls from low socio-economic group. This may be in relation to lesser height and weight in children from low socio-economic group than children from high socio-economic group. This is shown in this study as the height and weight were in the lower range for low socio-economic group.

We found that both systolic and diastolic blood pressure increased with increase of weight. Similar findings were observed by Faber, Robinson, Bruce and Hahn.[7, 21] The same was also observed by Agarwal VK, Sachdev Y and Weiss et al.[19,17,20]

In the present study there is progressive increase in both systolic and diastolic blood pressure for both sexes with increase in height. But there is no significant correlation noted between blood pressure and height by other authors like Feber, Master et al and Agarwal VK.[19,21]

Incidence of hypertension

The dividing line for hypertension was described by Master et al. as above 95th percentile and +2 SD above

mean by Dube and Rames et al.[22,23] We have kept values above +2 SD as hypertensive and results revealed 9.54% prevalence of hypertension in children.

Prevalence of hypertension in children as observed by other investigators. This study correlates with that of Hahn.[7] But prevalence of hypertension in other studies is very low. This diversity in prevalence may be due to varying age groups taken for study and different criteria adopted for defining hypertension, basic difference between racial subgroups related to geographic, dietary and cultural factors. Familial aggregation of blood pressure, unidentified genetic factors and anatomical variants of regional circulation may also change the demographic pattern from time to time.

Obesity and hypertension

The prevalence of obesity in the present study is 0.69%. Prevalence of hypertension in obese children is 64.29% when compared to 7.19% in non-obese children. Prevalence of obesity in the present study is very less when compared to other studies 52%, 62.5%, 53% and 63%.[15,12,24,25] This may be due to the nutritional status, body proportions like height and weight observed in various groups.

Investigation of these hypertensive children failed to document any underlying cause. The hypertension in these asymptomatic children is therefore, essential hypertension which is probably aggravated due to obesity in some children.

CONCLUSION

Blood pressure measurement in children is pivotal in clinical examination. It shows a linear relationship with age and varies across socio-economic status. Periodic recording of BP would enable identify hypertension at an early age.

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