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Original Research Article

Study of blood pressure in relation with age, sex and BMI in school going children of age group 5-15 years in Amalapuram, Andhra Pradesh, India

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ABSTRACT

Background: The measurement of blood pressure is an important component of routine Pediatric physical examination. Children with higher levels of blood pressure tend to maintain higher blood pressure levels in adulthood in comparison to their peer group. The aims and objectives of this study were to define the normal pattern of blood pressure and prevalence of hypertension in urban school children between the age group of 5-15 years and to evaluate relationship of blood pressure with variables such as age, sex, height, weight and BMI in Amalapuram, Andhra Pradesh.
Methods: This was a prospective cross-sectional observational study conducted from July 2016 to December 2018 in Department of Pediatrics, KIMS Amalapuram.
Results: The overall prevalence of hypertension in the present study was 3.2%. Of these 16 children 11 were males amounting to 4.41% of total number of males and 5 were females amounting to 1.99% of total number of females. The prevalence of hypertension was more in the males. It was observed that there is not much increase in mean blood pressure up to 130 cms (both in males and females) and increased significantly and gradually in children above 130 cms of height. Blood pressure increases gradually and in a proportionate manner with increase in weight and BMI.
Conclusions: Blood pressure is an important vital sign which reflects the integrity of the cardiovascular system, renal, endocrinal system and other systems in the body. Blood pressure of an individual varies with age, sex, height, weight and BMI. It also has a strong correlation with family history of hypertension. Thus, concluded that hypertension has its roots in childhood and early adolescence.

Keywords: Blood pressure, Childhood, Height, Hypertension, Weight

INTRODUCTION

The measurement of blood pressure is firmly considered as an important component of routine pediatric physical examination.[1] Norms for blood pressure and definition of hypertension were revised and strengthened by "The fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents April 29, 2004".[2] Blood pressure should be measured yearly after the age of three years.[2]

Hypertension has its origin in childhood but goes undetected unless specifically looked for during this period. Accurate measurement of blood pressure may be difficult in children because the readings vary significantly with cuff size, patient positioning, clinical

setting, equipment used (mercury sphygmomanometer versus oscillometric methods) and training of the observer.[3]

Blood pressure is considerably lower in children than adults but almost always increases steadily throughout the first 2 decades of life.[2,4-6] Hypertension is a major health problem in developed and developing countries associated with high mortality and morbidity affecting approximately 1 billion individuals worldwide. The prevalence of hypertensive in children is reported to be 1-3%.[7] Elevated blood pressure in children and adolescents may be an early expression of essential hypertension in adulthood.[2,8,9] It is also observed that although blood pressure normally increases with growth and development, children with higher levels of blood pressure tend to maintain those higher levels in adulthood in comparison to their peer group.

Juvenile blood pressure was found to be one of the several predictors of adult blood pressure.[10,11] There is no long-term outcome data relating blood pressure in childhood or adolescence to cardiovascular risk in adulthood. The blood pressure profiles vary in childhood with age sex, weight, height, body mass index (obesity), family history of hypertension, socio-economic status and dietary habits.[2,12,13] Studies have concluded that both systolic and diastolic blood pressure have a direct correlation with weight and with height (independent of age).[13-19]

Few studies have also shown that obese children have an increased systolic and diastolic blood pressure levels.[2,20-22] Reference norms developed for one particular population may not be applicable to other because of racial, ethnical and cultural difference across the world.[8,11,17,18] There are number of studies conducted in different parts of the world regarding pediatric blood pressure profiles and its correlation with weight, height and body mass index, but there is paucity of studies in Indian context. The local reference data is essential to evaluate any observed blood pressure values.

The aim and objectives of this study were to define the normal pattern of blood pressure in urban school children between the age group of 5-15 years, to evaluate the relationship of blood pressure with variables such as age, sex, height, weight and BMI, to find out prevalence of hypertension in children in Amalapuram.

METHODS

A prospective cross-sectional observational study was done from the period of July 2016 to December 2018 in Department of Pediatrics, KIMS Amalapuram. This study was carried out in private school (Param Jyothi public school) in Amalapuram. The study sample consisted of 500 students apparently healthy school going children, in the age group of 5-15 years.

All the cases were selected by simple random sampling method after taking well informed consent from their parents. A short history about febrile illness, burning micturition, cough, dyspnea /breathlessness was taken. A complete general physical examination and head to toe examination was done. Vitals and temperature were recorded. Child was clinically assessed for anemia, jaundice, cyanosis, clubbing, lymphadenopathy, edema and was looked for any congenital anomalies. A thorough systemic examination of all systems (RS, CVS, GIS, CNS) was done to exclude the systemic disorders like congenital heart disease, renal disorders and liver diseases.

Inclusion criteria

- School going healthy children between the age group of 5 to 15 years.

Exclusion criteria

- Children suffering from chronic illness
- Children on long term medications
- Children with any congenital anomalies.

Parameters studied under the present study

A proper history of all students was taken. History about febrile illness, burning micturition, cough, dyspnea/ breathlessness was taken. A complete general physical examination and head to toe examination was done. Vitals and temperature were recorded. Child was clinically assessed for anemia, jaundice, cyanosis, clubbing, lymphadenopathy and edema and was looked for any congenital anomalies. A thorough systemic examination of all systems (RS, CVS, GIS, CNS) was done to exclude the systemic disorders like congenital heart disease, renal disorders and liver diseases. The following parameters were studied in all the study subjects. Age, sex, weight, height, body mass index (kg/m^2), systolic and diastolic blood pressure.

A written proforma was sent home with the child to collect information about family history of hypertension (father/mother), diet history (Veg/Non-veg) and socio-economic status (per capita income) and the same were collected after 2 days. Age in completed years was recorded according to the school admission registers. Measurements were made by a single person and same equipment was used to obtain accurate measurement and to increase the sensitivity of the results.

Weight was measured in kg's using a dial type of weighing machine and all recordings including blood pressure measurements was done by a single individual to eliminate observers subjective bias. Height was measured to nearest 1cm with subject standing without shoes using a non-stretchable metallic tape.

Measurement of blood pressure: Before recording blood pressure, the procedure was explained to children and sufficient time was given to allay anxiety and fears. Blood pressure was measured using Diamond mercury manometer with a set of different sized cuffs as per the recommendation given by the fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents 2004.[2] The cuff bladder was wide enough to cover at least 2/3rd of arm and long enough to encircle arm completely. Auscultatory method was used and the 1st and 5th Korotkoff's sounds were taken as indicative of the systolic and diastolic blood pressure respectively. Blood pressure was recorded 3 times with 2 min interval between each measurement.

In children where a higher range of blood pressure was observed, the factors like anxiety and fear were removed and re-recorded after one hour. Average of 3 BP readings was taken as the final value. BMI was calculated using the formula. (weight in kg/height in metre^2). Correlation coefficient and simple linear regression analysis was done for predicting blood pressure (SBP and DBP) separately for age, sex, weight, height and body mass index. Norms were established for each individual age, height, weight and BMI (kg/m^2).

Statistical analysis

The data was analyzed by Karl-Pearson's coefficient of co-relation and regression. Ethics clearance and informed consent: The present study was approved by Institutional ethical committee.

RESULTS

The blood pressure was recorded in 500 students from age group of 5 years to 15 years considering the inclusion and exclusion criteria. Among 500 students, 249 were males and 251 were females.

The mean systolic blood pressure in males at 5 years was 98.21 mm of Hg and at 10 years was 102.81 mm of Hg. The mean SBP in males at 11 years was 103.77 mm of Hg and at 15 years was 113.13 mm of Hg. In this study, it was observed that there is not much difference of SBP between age 5 to 10 years (differences are approximately 3-4mm of Hg) but SBP increased remarkably after 11 years of age. The mean SBP in females at 5 years was 96.91 mm of Hg and at 10 years was 101.90 mm of Hg.

The mean SBP in females at 11 years was 104.23 mm of Hg and at 15 years was 110.78 mm of Hg. From these readings, it was observed that SBP did not vary much between 5-10 years and the same increased significantly after 11 years of age. The correlation coefficient for relationship between age and SBP in males and females was 0.79 and 0.86 respectively with significant P-value (P<0.001) (Table 1).

Table 1: Relationship of systolic blood pressure (SBP) according to age and sex.

	Males			Females		
Age	**No. of cases**	**Mean**	**SD**	**No. of cases**	**Mean**	**SD**
5	22	98.21	2.20	22	96.91	3.28
6	22	99.48	4.95	22	96.27	3.49
7	23	100.17	3.36	23	97.89	2.11
8	22	102.14	4.59	23	97.89	2.11
9	22	101.45	1.19	23	99.65	1.47
10	23	102.81	4.49	23	101.90	4.48
11	23	103.77	1.77	23	104.23	2.39
12	23	105.48	1.87	23	105.80	1.29
13	23	108.03	1.56	23	108.78	1.22
14	23	111.25	4.42	23	107.80	1.34
15	23	113.13	1.82	23	110.78	2.87

The mean diastolic blood pressure in males at 5 years was 61.38 mm of Hg and at 10 years was 64.88 mm of Hg. The mean DBP in females at 5 years was 58.54 mm of Hg and at 10 years was 63.57 mm of Hg.

In this study, it was observed that there is not much increase in DBP between age 5 years to 10 years, in both males and females. The mean DBP in males at 11 years was 64.84 mm of Hg and at 15 years was 71.86 mm of Hg. The mean DBP in females at 11 years was 63.62 mm of Hg and at 15 years was 67.91 mm of Hg. In this study, it was observed that there is significant increase in DBP from age 11 years to 15 years, both in males and females. The correlation coefficient for relationship between age and DBP in males and females was 0.79 and 0.83 respectively with significant P-value (P<0.001) (Table 2).

Table 2: Relationship of diastolic blood pressure (DBP) according to age and sex.

	Males			Females		
Age	**No. of cases**	**Mean**	**SD**	**No. of cases**	**Mean**	**SD**
5	22	61.38	1.27	22	58.54	3.42
6	22	60.12	4.77	22	57.82	2.66
7	23	61.77	1.67	23	59.07	1.53
8	22	63.24	3.81	23	61.80	1.09
9	22	63.70	0.96	23	61.45	1.36
10	23	64.88	3.64	23	63.57	3.61
11	23	64.84	1.16	23	63.62	1.61
12	23	66.09	0.79	23	64.32	0.92
13	23	67.94	0.90	23	65.77	1.61
14	23	69.63	2.99	23	66.55	0.94
15	23	71.86	1.04	23	67.91	1.14

Based on height of the individual student, 7 groups were made, independent of age and weight with a difference of 10cm between the groups. It was observed that there is not much increase in mean SBP up to 130cm (both in males and females) and SBP increased significantly and gradually in children above 130cm of height. The

correlation coefficient for relationship between height and SBP in males and females is 0.82 and 0.89 respectively with significant P-value(P<0.001) (Table 3).

Table 3: Relationship of systolic blood pressure (SBP) according to height.

	Males			Females		
Height	**No. of cases**	**Mean**	**SD**	**No. of cases**	**Mean**	**SD**
100-110	14	98.07	2.23	15	96.02	0.93
110-120	45	99	3.82	47	97.18	3.46
120-130	53	101.97	3.25	56	99.29	1.90
130-140	37	103.03	3.61	29	102.54	3.88
140-150	37	105.68	1.95	45	106.33	1.57
150-160	42	109.92	3.72	56	108.99	1.99
160-170	21	113.46	1.53	3	115.33	0.67

It was observed from above readings that there was not much increase in DBP both in males and females up to a height of 130cm, but DBP increased significantly and gradually between 130cm to 170cm.

The correlation coefficient for relationship between height and DBP in males and females is 0.80 and 0.84 respectively with significant P-value (P<0.001) (Table 4).

Table 4: Relationship of diastolic blood pressure (DBP) according to height.

	Males			Females		
Height	**No. of cases**	**Mean**	**SD**	**No. of cases**	**Mean**	**SD**
100-110	14	61.50	2.11	15	57.73	1.30
110-120	45	60.62	3.30	47	58.45	2.90
120-130	53	63.41	2.61	56	61.68	1.30
130-140	37	64.75	2.95	29	63.75	3.21
140-150	37	66.24	0.98	45	64.31	1.49
150-160	42	69.13	2.52	56	66.89	1.49
160-170	21	71.78	1.06	3	69.11	0.38

The weight of 500 students was divided into 8 groups, independent of age and height of the children with a difference of 5 kg's between each group. The mean SBP and DBP was calculated and same has been displayed in (Table 5 and 6).

In this study, it was observed that the mean systolic blood pressure in both males and females increased gradually from 15 kgs to 50 kgs weight (Table 5).

It was also observed that the mean DBP in both males and females increased gradually from 15 kgs to 50 kgs.

There is an increase of 2-3 mm of Hg in both SBP and DBP for every 5 kgs weight.

Table 5: Relationship of mean SBP according to weight.

	Males			Females		
Weight (kg)	**No. of cases**	**Mean SBP**	**SD**	**No. of cases**	**Mean SBP**	**SD**
15-20	43	98.15	2.70	50	96.36	2.28
20-25	67	101.59	3.75	66	99.28	2.63
25-30	32	103	3.86	25	102.09	4.24
30-35	31	104.49	1.64	30	105.18	1.68
35-40	22	107.15	1.62	23	107.36	1.67
40-45	27	109.88	1.32	38	108.32	1.40
45-50	27	113.60	3.84	19	111.16	3.04

The correlation coefficient for relationship between weight and SBP in males and females was 0.84 and 0.89 respectively with a significant P-value(P<0.001). The correlation coefficient for relationship between weight and DBP in males and females was 0.83 and 0.83 respectively with a significant P-value (P<0.001) (Table 6).

Table 6: Relationship of mean DBP according to weight.

	Males			Females		
Weight (kg)	**No. of cases**	**Mean DBP**	**SD**	**No. of cases**	**Mean DBP**	**SD**
15-20	43	98.15	2.70	50	96.36	2.28
20-25	67	101.59	3.75	66	99.28	2.63
25-30	32	103	3.86	25	102.09	4.24
30-35	31	104.49	1.64	30	105.18	1.68
35-40	22	107.15	1.62	23	107.76	1.67
40-45	27	109.88	1.32	38	108.32	1.40
45-50	27	113.60	3.84	19	111.16	3.04

Body mass index (BMI) was calculated using the formula. BMI (kg/m²) =Wt (kg)/Ht (mt)² The BMI of 500 students was divided into 5 groups, with a difference of 2 kg/m^2 between each group.

Table 7: Relationship of mean SBP according to BMI.

	Males			Females		
BMI	**No. of cases**	**Mean SBP**	**SD**	**No. of cases**	**Mean SBP**	**SD**
12-14	14	98.62	2.75	29	96.99	2.19
14-16	133	101.43	3.92	199	100.16	3.96
16-18	72	107.39	4.31	66	106.26	4.61
18-20	30	111.69	4.04	37	108.94	2.28

The mean SBP and DBP was calculated and same has been displayed in (Tables 7 and 8) respectively. In males with BMI between 12 to 14 kg/m^2, the mean SBP was 98.62 mm of Hg and in BMI between 18-20 kg/m^2, the mean SBP was 111.69 mm of Hg. In females with BMI

between 12-14 kg/m^2 mean SBP was 96.99 mm of Hg and BMI between 18-20kg/m^2, the mean SBP was 108.94 mm of Hg (Table 7).

Table 8: Relationship of mean DBP according to BMI.

	Males			Females		
BMI	**No. of cases**	**Mean DBP**	**SD**	**No. of cases**	**Mean DBP**	**SD**
12-14	14	98.62	2.75	29	96.99	2.19
14-16	133	101.43	3.92	119	100.16	3.96
16-18	72	107.39	4.31	66	106.26	4.61
18-20	30	111.69	4.04	37	108.94	2.28

In males with BMI between 12-14kg/m^2, mean DBP was 61.22mm of Hg and BMI between 18-20kg/m^2, mean DBP was 70.87mm of Hg. In females with BMI between 12-14kg/m^2, mean DBP was 58.60mm of Hg and BMI between 18-20kg/m^2, mean DBP was 66.88 mm of Hg. It was observed that as BMI increased, both SBP and DBP increased gradually and significantly (Table 8). The correlation coefficient for relationship between BMI and SBP in males and females was 0.74 and 0.76 respectively with significant P-value (P<0.001). The correlation coefficient for relationship between BMI and DBP in males and females was 0.76and 0.72 respectively with significant P-value (P<0.001).

Based on the mean systolic and diastolic blood pressure readings obtained in our study, the correlation coefficient and regression coefficient were calculated and prediction equation for systolic and diastolic blood pressure for that particular age, height, weight and BMI were obtained (Table 9).

Table 9: Predictions of SBP And DBP for age, height, weight and BMI.

Relationship between	Sex	Correlation coefficient	Significance	Prediction equation
Age and SBP	Male	0.79	P < 0.001	SBP=90.12+1.4 (Age)
	Female	0.86	P < 0.001	SBP=87.49+1.51 (Age)
Age and DBP	Male	0.79	P < 0.001	DBP=54.49+1.05 (Age)
	Female	0.83	P < 0.001	DBP=52.85+0.99 (Age)
Height and SBP	Male	0.82	P < 0.001	SBP=67.32+0.27 (Height)
	Female	0.89	P < 0.001	SBP=61.51+0.30 (Height)
Height and DBP	Male	0.80	P < 0.001	DBP=37.94+0.2 (Height)
	Female	0.84	P < 0.001	DBP=36.42+0.19 (Height)
Weight and SBP	Male	0.84	P < 0.001	SBP=90.03+0.46 (Weight)
	Female	0.89	P < 0.001	SBP=87.67+0.50 (Weight)
Weight and DBP	Male	0.83	P < 0.001	DBP=54.53+0.35 (Weight)
	Female	0.83	P < 0.001	DBP=53.24+0.32 (Weight)
BMI and SBP	Male	0.74	P < 0.001	SBP=58.71+2.86 (BMI)
	Female	0.76	P < 0.001	SBP=62.31+2.54 (BMI)
BMI and DBP	Male	0.74	P < 0.001	DBP=29.60+2.23 (BMI)
	Female	0.72	P < 0.001	DBP=36.83+1.63 (BMI)

Table 10: Prevalence of hypertension among children.

Age	Males	With hypertension	Percentage	Females	With hypertension	Percentage
5	22	0	0	22	0	0
6	22	1	4.54	22	1	4.54
7	23	1	4.34	23	1	4.34
8	22	1	4.54	23	1	4.34
9	22	2	9.09	23	0	0
10	23	1	4.34	23	0	0
11	23	1	4.34	23	0	0
12	23	2	8.68	23	0	0
13	23	0	0	23	0	0
14	23	1	4.34	23	2	8.68
15	23	1	4.34	23	0	0
	Total males	11	4.41%	Total females	5	1.99

Prevalence of hypertension

As per the definition's children with values above 95th percentile was labelled as hypertensive (Table 10). In the present study, 500 children were analyzed, and 16 children were labelled as hypertensives giving a prevalence of 3.2%. Out of the 16 children found to be hypertensive, 11 children were males and 5 children were females. All these 16 children had their blood pressure elevated mildly above 95th percentile. No. of child had blood pressure above 99th percentile (Table 10).

DISCUSSION

In all the studies in India and abroad, it has been shown that blood pressure, both systolic and diastolic, gradually increases with age, although such an increase is not a steady one. The findings of the present study are in agreement with the above statement. The findings of the present study regarding mean systolic and mean diastolic pressure are comparable with findings of the study conducted by Anand NK et al and Tandon L et al.[23] Their findings (systolic blood pressure) of 94.1 mm Hg at 5 years and 116.5 mm Hg at 15 years for boys and 92.6 mm Hg at 5 years and 116.4 mm Hg at 15 years for girls are close to the findings of the present study. Similarly, mean diastolic pressures for both boys and girls in the present study and study conducted by Anand NK et al and Tandon L et al are comparable.[23]

The systolic spurt observed in the present study between 13-14 years in both sexes has been supported by Agarwal Rajiv Sharma, Shrivastava AK et al, Kumar P et al and Pandey CM et al, who observed similar spurts in systolic blood pressure in both sexes between 12 and 13 years of age.[16] Agarwal R et al, Mandowara SL et al, Bhandari B et al and Garg OP et al, also observed a spurt in blood pressure between 12 and 13 years.[24] The steep rise in systolic blood pressure was also observed by Londe between 5 to 6 years in boys, 4 to 5 years in females and between 14 to 15 years in both sexes.28 However, task force committee USA reported only one spurt between 5 and 6 years in both the sexes.

The gradual increase in the blood pressure along with increase in age can be explained by the fact that, the body mass also increases, which is one of the determinants of blood pressure, along with age. The systolic spurt observed in the present study can be accounted by the onset of puberty in both sexes, which results in increase of body weight and height, as a result of increase in muscular tissue in boys and deposition of adipose tissue in girls, which begins around 11 to 12 years and reaches peak levels by 14-15 years of age. Male students had 1-2 mm of Hg of height blood pressure when compared with their female counterparts at all ages. This is similar to the average annual of 2 mm of Hg in boys and about 1 mm of Hg in girls reported by world health organization study group. The observations of mean diastolic pressure in the present study resemble those of the study conducted by Anand NK et al and Tandon L et al.[23] In the present study, it ranged from 61.38 mm Hg at 5 years to 71.86 mm Hg at 15 years in boys whereas from 58.54 mm Hg at 5 years to 67.91mm Hgat15 years in girls.

In the study conducted by Anand NK et al and Lalit Tandon L et al, it ranged from 62.2 mm Hg at 5 years and 76.9 mm Hg at 15 years in boys and 62 mm Hg at 5 years and 76.3 mm Hg at 15 years in girls.[23] Agarwal R et al, Mandowara SL et al, Bhandari B et al and Garg OP et al, reported a diastolic blood pressure range of 65 to 77 mm Hg for boys and 67 to 78mm Hg for girls in 5-15 years age group.[24] All the above studies, including present study show an approximate increase of diastolic blood pressure by 1 mm Hg per year of age. Height is an easily measured indicator of physiological maturity in a clinical setting and is better correlated with skeletal age than the chronological age. Height is related to blood pressure independent of age.[2,18]

Thus the most powerful determinant of normal blood pressure change in an individual is maturation, not chronological age.[18] In our study, the mean systolic and diastolic blood pressure in both sexes increased 2-3 mm of Hg for every 10 cms increase in height, independent of age and weight. It was also observed that mean systolic and diastolic blood pressure showed an increase of 2-3 mm of Hg upto a height of 130cms in both sexes and blood pressure increment was more pronounced (3-4 mm of Hg) in students who are more than 130 cms tall (both sexes). This probably would be explained that blood pressure does not have a simple linear correlation with height as it is thought or other factors like hormonal, emotional factors can be credited for this observation. In our study, the relation of systolic and diastolic blood pressure with height is independent of age. Similar results were shown by other studies.[6,8,18]

Hence, height has to be considered independent of age before classifying the child as prehypertensive/ hypertensive. That means taller children are allowed higher normal blood pressure when their height is taken into consideration than when age is used alone. On the other hand, more short children and adolescents are identified as having high normal or mildly elevated blood pressure when only age and sex derived data is used. This is important in pediatric practice when dealing with chronic conditions resulting in short stature such as renal and hepatic insufficiency, hypothyroidism, Cushing syndrome, Sickle cell disease and turner syndrome. Thus, the blood pressure normograms obtained according to height is always recommended to be used in pediatric practice. In our study, the mean systolic blood pressure for males and females between 15-20 kg was 98.15 and 96.36 mm of Hg respectively.

There was an increase in 2 mm of Hg in systolic blood pressure for every weight group up to 50kg's. The mean diastolic blood pressure for male and females between 15-20 kg's is 60.25 mm of Hg and 57.73 mm of Hg respectively. There was an increase in 2.5-3 mm of Hg in diastolic blood pressure for every weight group up to 50kg.The study done by Agarwal et al, also showed a similar trend, but the increase in mean systolic and diastolic blood pressure was 1-1.5 mm of Hg and 1.5- 2 mm of Hg respectively with increase of every 5 kg's weight.[24] The difference is possibly due to the sample size where Agwarwal et al, study sample size was nearly two and half times of our sample size (2645 versus 500).[24] And also the present study was done in a private school where most of the students belongs to higher socio-economic status (modified Kuppuswamy classification). It is known that higher blood pressure values are described in families belonging to higher socio-economic status due to nutritional and psychological factors. Agarwal et al, used Korotkoff's phase IV to determine diastolic blood pressure, but authors used Korotkoff's phase V as diastolic blood pressure.[16] In our study, it was also noted that the increase in diastolic blood pressure according to weight was more pronounced than increase in systolic blood pressure (2 mm versus 3 mm of Hg) which was unexplainable. More larger studies are needed and explanation to be given to prove this. Objectively measured by body mass index (BMI = weight in kg/ height in meter^2) measure of obesity. It is well known that obesity is associated with stroke, atherosclerosis, coronary artery disease and endocrinal disorders. The association between hypertension and obesity in adults is well established.[2,19,25] But relationship between hypertension and obesity in childhood has been noted, but less extensively evaluated. In our study, the mean systolic and diastolic blood pressure increased by 3-4 mm of Hg with increase in every 2 kg/m^{2}of BMI (each group) This study shows a positive linear association of BMI with systolic and diastolic blood pressure in both sexes. Similar results were obtained by other studies.[6,8,20,26]Thus concluding that obese children have higher levels of blood pressure when compared to their normal counterparts. However, there is paucity of information about the possible mechanism to relate obesity and higher blood pressure values. Those postulated include increased cardiac output, increased blood volume, excessive sodium intake as a consequence of excessive calorie intake, increased steroid production and alteration in receptors in various pressure substances.[19,25,27] Thus, it is logical to advice families with obese children to change their life styles with respect to diet, exercise and reduced salt intake to get their children accustomed to lifestyles, which are favorable for the maintenance of normal blood pressure. Based on the predictive equation, norms were obtained for both systolic and diastolic blood pressure based on the observed readings and the upper and lower limits of systolic and diastolic blood pressure for that age was obtained for the local population from 5-15 years age group.

Prevalence of hypertension

In the present study, the prevalence of hypertension was found to be 3.2% (95th percentile for age and sex was cut-off point). Other workers reported a wide range of figures. The true incidence of hypertension among children and young adolescents remains unclear and depends on the definition of hypertension. Some workers consider a child as hypertensive if his/her blood pressure is more than two standard deviations above the mean for his/her age on one or more occasions. Various authors have claimed that 1-11.5% of children will have mild elevation of blood pressure. But the true incidence lies between 1 to 3%.The vast majority of these children will have mild elevation of blood pressure and labelled as essential hypertensives.[11] The observation of the present study is in agreement with the above statement as all the 32 children who were labelled as hypertensives had only mildly elevated blood pressure and none had severe elevation of blood pressure (> 99th percentile). The prevalence of hypertension in the present study (3.2%) was comparable to most of the studies conducted in India.

Table 11: Prevalence of hypertension among children in various studies.

Studies	Prevalence of hypertension
Londe et al[28]	2.3%
Sukumar et al[29]	2%
Agarwal R et al[24]	2.6%
Agarwal VK et al[16]	1.8%
Chahar CK et al[30]	1.39%
Sachdev et al[31]	0.54%
Laroia D et al[32]	2.93%
Anand NK et al[23]	0.46%
Present study	3.2%

CONCLUSION

Blood pressure is an important vital sign which reflects the integrity of the cardiovascular system, renal, endocrinal system and other systems in the body. Blood pressure of an individual varies with age, sex, height, weight and BMI.It also has a strong correlation with family history of hypertension. Thus, concluding that hypertension has its roots in childhood and early adolescence. No longitudinal study could be carried out to correlate the childhood blood pressure values with that of adulthood blood pressure values. Regular screening of blood pressure be made as a part of health care in school children to prevent CVS, CNS, Renal and other complications. Educating the parents and public about the diet, exercise and prevention of childhood obesity is important in prevention of adulthood hypertension. Therefore, early diagnosis of childhood hypertension is recommended to prevent the further complications.

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