e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2023; 13 (7); 281-287

Original Research Article

A Study of Association of Blood Pressure Distribution with Age, Anthropometric Measurements, and Socioeconomic Status in School Children

Mohd. Sirazuddin[1], N. Ranjith Kumar[2], Cheguru Sripal Reddy[3]

[1] Assistant Professor, Dept. of Pediatrics, Government Medical College Mahabubnagar, Telangana State.
[2] Assistant Professor, Dept. of Pediatrics, Government Medical College, Mahabubnagar, Telangana State.
[3] Assistant Professor, Dept. of Pediatrics, Government Medical College, Mahabubnagar, Telangana State.

Received: 25-05-2023 / Revised: 28-06-2023 / Accepted: 20-07-2023
Corresponding author: Dr. Mohd. Sirazuddin
Conflict of interest: Nil

Abstract:

Background: Numerous studies have established standard blood pressure norms for children of different ages and races in their respective countries. Over the past four decades, there has been a two-fold increase in rural and a six-fold increase in urban areas. Various environmental and genetic factors, such as sex, body surface area (BSA), obesity, family history of hypertension, dietary habits, physical activity, stress, race, ethnicity, and socioeconomic status, play a role in influencing blood pressure among children and adolescents.

Methods: This cross-sectional study was conducted in Mahbubnagar city, spanning school children aged 5 to 16 years from 11 randomly selected schools (Government and Private) based on a simple random sampling method from a provided list. Before commencing the study, clearance was obtained from the institutional ethical committee, and permission was granted by the school authorities.

Results: There is a linear increase in mean blood pressure (BP) concerning age, sex, weight, height, social status, and locality. However, diastolic blood pressure (DBP) shows a strong negative correlation with sex, indicating that females have higher DBP, and children from lower socioeconomic classes and rural areas tend to have higher DBP levels. Furthermore, 27 children with a parental history of hypertension are found to be above the 85th and 95th percentiles. Both sexes demonstrated a positive correlation between BP and BMI.

Conclusion: we observed similar results were observed for both sexes regarding systolic blood pressure (SBP) and diastolic blood pressure (DBP). We noted a linear increase in mean SBP and DBP with advancing age, weight, height, and BMI. Moreover, there was a direct correlation between a family history of hypertension and high socioeconomic status (SES) with SBP and DBP levels. Specifically, class I SES exhibited higher mean SBP than class III SES.

Keywords: Body Mass Index, Body surface area, Diastolic blood pressure, School children, Systolic blood pressure, Socioeconomic status.

Introduction

Hypertension is a significant disease with a prevalence of 1-2% in developed countries, leading to considerable morbidity and accounting for 12.8% of global deaths. It is a prominent condition affecting children, with essential hypertension being the most common form, particularly prevalent in large metropolitan cities in India, along with an increased incidence of coronary heart disease in urban populations over 20 years of age. [1] Over the past four decades, there has been a notable upward trend, with hypertension now reaching smaller cities in India due to nutritional transition, resulting in a two-fold increase in rural areas and a six-fold increase in urban areas. Several modifiable factors, including sex, body size, obesity, family history of hypertension, altered dietary habits, physical activity, race, ethnicity, and socioeconomic status directly influence the development of hypertension among children and adolescents.

Numerous countries have conducted studies to set normative blood pressure standards for children based on sex and race. [2] However, these standards cannot be directly applied to Indian children due to variations in ethnic, socioeconomic, dietary, environmental, and emotional factors. Unfortunately, reliable statistics on this matter are not currently available in India. Therefore, it is crucial to establish routine annual physical examinations for Indian children above the age of 3 years to enable early detection of any potential issues and to develop specific blood pressure standards for this population. [3] In low- and middle-income countries, especially in urban areas, there is an upward trend in overweight and obesity rates. This increase in overweight and obesity has been associated with insulin resistance and a simultaneous rise in blood pressure among children. The World Health Organization (WHO) reported that as of 2010, approximately 43 million children under 5 years of age were overweight. [4] Hence, the main objectives of this study were to assess the blood pressure levels of school-going children aged 5–16 years in Mahbubnagar City, Telangana, and to create a tabulated percentile distribution based on the findings.

Material and Methods

This cross-sectional study was conducted in Mahbubnagar city, spanning school children aged 5 to 16 years from 13 randomly selected schools (Government and Private) based on a simple random sampling method from a provided list. Before commencing the study, clearance was obtained from the institutional ethical committee, and permission was granted by the school authorities.

The study included healthy and asymptomatic school children within the specified age range, while children under 5 years and above 16 years, as well as those with known Cardiovascular, Renal, and endocrine diseases, were excluded from the study. The age of the school children was obtained from school records, and their names and general information were entered into a pretested Performa after obtaining consent from their parents.

Height measurements were taken using a sliding stadiometer (Johnson and Johnson) with an accuracy of 0.1 mm, and weight was recorded using a standard spring balance scale calibrated to 0.5 kg accuracy. BMI for boys and girls was calculated using the formula $BMI = kg/m^2$ as per WHO guidelines. Before recording blood pressure, the children were taken to a separate room away from the noise, where they were thoroughly explained the procedure of blood pressure recording. Efforts were made to eliminate factors that might affect blood pressure readings to record them under basal or near basal conditions. [5] Blood pressure recordings were expressed to the nearest 10 mm Hg. Two blood pressure readings were taken from each child, one at 0 minutes and another at 2 minutes, using the auscultatory method. The average of these two readings was considered as the individual's blood pressure. All blood pressure recordings were taken at the same time of day, during interval hours, and were recorded by the same person using the same instrument. The distribution of blood pressure was studied based on anthropometric characteristics such as age, sex, height, weight, BMI, family history of hypertension, and socio-economic status.

Statistical analysis: For statistical analysis, all results were tabulated and analyzed using IBM SPSS software Version 17.0. The Chi-square test was used to assess statistical significance. Mean and standard deviation were calculated for categorical data, and the data were further analyzed using ANOVA. Charts were prepared using Microsoft Excel 2007 Version.

Results

Out of a total of 2019 children examined in the study Boys were 1013 (50.17) and Girls 1006 (49.82%). For children of all age groups sex ratio was approximately equally maintained except at 10 years, 11 years, and 12 years where proportionately a greater number of boys were present as compared to girls. The common age group was 11 – 13 years with 39.97% of all the children studied. The mean age of the girls in the study was 13.2 ± 3.5 years and the mean age of the boys was 13.8 years ± 2.8 years. The detailed distribution of the cohort based on age and sex is given in Table 1.

Table 1: Age-wise distribution of boys and girls included in the study.

Age In Years	Girls	Percentage	Boys	Percentage
5	25	2.48	24	2.36
6	51	5.06	52	5.13
7	63	6.26	62	6.12
8	71	7.06	59	5.82
9	82	8.15	73	7.20
10	110	10.93	91	8.98
11	131	13.02	167	16.48
12	118	11.73	156	15.40
13	123	12.22	112	11.05
14	109	10.83	107	10.56
15	101	10.03	88	8.68
16	22	2.18	22	2.17
-	1006	100.00	1013	100.00

The study reveals a direct correlation between age and Mean Blood Pressure, where it consistently increases as age advances. In the study group, the average Systolic Blood Pressure (SBP) was measured at 97.47 mmHg, while the Diastolic Blood Pressure (DBP) was recorded at 63.29 mmHg. For boys, the mean SBP at 5 years old was 79.01 mmHg, which rose to 113.63 mmHg at 16 years old. Conversely, girls exhibited an average SBP of 81.55 mmHg at 5 years old, increasing to 106.96 mmHg at 16 years old (Table 2). Regarding DBP, boys had an average of 48.88 mmHg at 5 years old, which increased to 67.50 mmHg at 16 years old. Interestingly, a linear rise in Diastolic BP was observed from 5 years to 13 years, followed by a slight surge at 12 and 16 years of age. As for girls, their average DBP was 54.98 mmHg at 5 years old, which increased to 69.50 mmHg at 16 years old there is a linear Increase in Diastolic BP with Age, except at 6 years where it is disproportionately lower (Table 2).

Table 2: Age-wise SBP and DBP (mmHg) in boys and girls

Age group	Mean Systolic Blood Pressure in mmHg		Mean Diastolic Blood Pressure in mmHg	
	Girls	Boys	Girls	Boys
5	81.55	79.01	54.98	48.88
6	85.03	85.32	53.04	57.11
7	88.10	87.52	56.41	59.30
8	91.52	91.03	61.73	57.64
9	95.90	94.61	64.78	63.20
10	97.20	97.04	64.69	63.41
11	99.11	100.02	65.74	65.59
12	103.10	102.65	66.84	68.63
13	104.39	104.62	66.59	67.21
14	107.11	108.59	69.56	68.48
15	106.28	109.42	68.32	69.58
16	106.69	113.63	69.50	67.97
Mean	97.165	97.788	63.51	63.08

The study findings indicate that there was a consistent and linear rise in both Mean Systolic and Diastolic Blood Pressures with increasing height as depicted in Table 3. Notably, a sharp increase in blood pressure was observed in individuals with a height exceeding 160 cm). There is a positive impact of height on both Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP). Similarly, we found a significant correlation between height and both systolic and diastolic blood pressures, further supporting the relationship between these factors (Table 3).

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

Height in cms	Boys			Girls		
	Sample Size	SBP±SD	DBP±SD	Sample Size	SBP±SD	DBP±SD
100-110	39	82.6 ± 3.72	52.33±2.10	41	84.22±0.35	54.34±2.60
111-120	101	86.68±2.68	54.80±0.14	93	87.56 ±3.06	57.14±3.74
121-130	155	93.69±1.89	60.37±0.17	160	92.09±1.44	60.90±2.25
131-140	231	98.63±3.27	63.80±3.16	178	98.13±3.18	63.42±1.78
141-150	145	103±0.38	67.11±1.49	195	101.78± 0.98	65.04±0.72
151-160	195	106.4±1.35	66.89±0.93	292	105.3±1.61	67.26±1.37
161-170	112	111.33±0.88	69.1±0.19	45	110.17±0.58	71.32±1.85
171-180	35	112.53±0.26	72.88±2.52	2	111.83 ± 2.5	72.17 ±1.7

Table 4: Distribution of SBP and DBP with relation to weight in boys and girls

Weight in Kgs	Boys			Girls		
	Sample Size	SBP	DBP	Sample Size	SBP	DBP
10-15	20	81.63 ± 2.25	49.72 ± 0.28	21	79.94 ± 2.3	48.27
16-20	92	86.75 ± 1.28	55.84 ± 0.67	103	87.56 ± 3.6	56.44
21-25	167	95.44 ± 3.54	61.14 ± 0.97	145	93.73 ± 4.1	60.04
26-30	145	99.73 ± 2.97	65.53 ± 0.84	134	97.57 ± 2.5	63.93
31-35	150	101.95 ± 1.09	66.62 ± 0.39	125	100.46 ± 2.8	62.74
36-40	135	105.35 ± 2.34	66.93 ± 0.97	149	100.74 ± 3.7	65.79
41-45	90	107.02 ± 2.33	66.67 ± 0.75	137	104.88 ± 2.3	67.43
46-50	103	111.24 ± 2.19	68.46 ± 0.68	110	110.72 ± 3.4	70.83
51-55	36	114.69 ± 3.01	73.09 ± 0.23	41	109.5 ± 1.25	68
56-60	40	114.29 ± 2.97	75.11± 0.98	22	115.58 ± 3.2	73.08

61-65	19	119.39 ± 2.33	78.08 ± 0.91	10	118.25 ± 2.9	78.51
66-70	4	116.03 ± 0.37	69.05 ± 0.82	3	123.15 ± 2.7	76.51
71-75	3	128.39 ± 3.33	84.45± 0.83	3	114.73 ± 3.9	81.68
76-80	6	117.56 ± 1.28	74.28 ± 0.67	2	118.9 ± 3.7	89.51
81-85	2	125.23 ± 5.32	92.95 ± 0.75	0	000	0.00
86-90	1	141.23 ± 10.2	85.95 ± 0.67	1	112.9 ± 2.7	62.51
Total	1013	110.23 ± 7.2	70.53 ± 0.97	1006	105.9 ± 6.4	68.10

In both males and females, there is a steady increase in the average systolic and diastolic blood pressures, with no significant difference observed between boys and girls (refer to Table 3). We found a direct correlation between blood pressure and weight in their study (table 4). Among the 2019 children studied, 45 children were between the 85^{th} and 95^{th} percentiles, while 5 children were above the 95^{th} percentile in terms of SBP and DBP. These groups exhibited significantly higher blood pressure compared to other BMI groups. Furthermore, there is a linear relationship between SBP and DBP with increasing BMI, as demonstrated in Table 4. It was found there is a positive correlation of mean SBP and DBP with anthropometric parameters, especially prominent in the age group of 12-16 years.

Table 5: Mean and SD of SBP and DBP in relation to BMI in boys.

Age	Sample Size	BMI ± SD	Systolic BP ± SD	Diastolic BP ± SD
5	25	15.18±2.53	79.55 ± 7.62	48.3 ± 9.13
6	55	15.84±2.67	86.32 ± 8.63	56.53 ± 10.3
7	61	15.15±2.64	88.80 ± 8.36	58.72 ± 9.09
8	66	15.45±2.73	92.03 ± 9.22	57.06 ± 8.48
9	74	15.84±2.94	95.61 ± 10.71	62.62 ± 11.18
10	92	16.27±3.10	98.04 ± 9.89	62.83 ± 11.07
11	155	16.73 ± 2.65	100.02 ± 10.10	65.01 ± 10.20
12	162	16.51 ± 2.90	103.6 ± 10.67	68.05 ± 10.15
13	119	17.64 ± 3.13	105.6 ± 9.5	66.63 ± 11.07
14	110	18.1 ± 3.36	109.4 ± 10.90	67.9 ± 11.58
15	69	18.16 ± 3.13	109.4 ± 9.95	69.0 ± 11.13
16	25	17.67 ± 3.43	113.3 ± 10.85	67.39 ± 11.12

Table 5: Mean and SD of SBP and DBP in relation to BMI in girls.

Age	Sample Size	BMI ± SD	Systolic BP ± SD	Diastolic BP ± SD
5	35	15.546 ± 3.2	81.37 ±8.42	53.89 ±10.72
6	64	15.14 ± 2.55	83.05 ±9.77	51.95 ±9.36
7	84	14.17 ± 2.58	88.02 ±8.73	55.32 ±8.71
8	81	15.08 ± 2.63	91.62 ±10.1	60.64 ±10.25
9	95	15.83 ± 2.82	95.96 ±9.99	63.69 ±9.69
10	124	15.95 ± 3.06	97.02 ±13.59	63.6 ±9.29
11	152	17.2 ± 3.23	99.17 ±10.74	64.65 ±10.17
12	140	17.49 ± 3.13	103.42±10.48	65.75 ±9.83
13	148	18.11 ± 3.27	104.3 ±10.83	65.5 ±10.38
14	128	19.28 ± 3.27	107.12±10.41	68.47 ±10.13
15	113	19.32 ± 3.10	106.46±11.04	67.23 ±9.86
16	26	19.79 ± 3.67	106.71+12.26	68.41 ±11.56

Children with a history of hypertension in either parent exhibited a statistically higher mean SBP (i.e., 112.16 mmHg) compared to children whose parents had a history of normotension (mean SBP: 98.29 mmHg). The difference was found to be highly significant (p-value 0.00001; Z = 21.77). This observation indicates that children with a family history of hypertension tend to have higher mean SBP and DBP than those without such a history.

The study population was categorized into five social groups based on the Modified Kuppuswamy Scale, [6] which considers factors such as parents' education, income, and occupation. In Class I SES (Socioeconomic Status), the mean SBP was 109.7 mmHg, while in Class III SES, it was 96.95 mmHg, indicating a significant difference (p-value 0.00001; Z = 22.16) (Table 6). However, most of the study population, 90% (1835 children), belonged to Class II SES. The study also depicted the SBP and DBP in children from rural and urban areas, with rural children showing higher blood pressure than urban children.

Table 6: Distribution of Mean SBP and DBP in Children with H/o HTN in Parents

H/O HTN in Parents	Total			Boys			Girls		
	Sample Size	SBP	DBP	Sample Size	SBP	DBP	Sample Size	SBP	DBP
Yes	195	112.16	72.51	126	114.14	73.33	116	110	71.6
No	1824	98.29	62.9	1105	98.92	63.19	1070	97.64	62.61

This study identified several factors that influence the occurrence of systolic blood pressure (SBP). Age, sex, social status, BMI, and locality were found to have a negative correlation with SBP, indicating that as these factors increase, SBP tends to decrease. On the other hand, weight and height showed a positive correlation with SBP, meaning that as weight and height increase, SBP also tends to increase. Children belonging to the upper class in urban areas displayed lower SBP levels, while those from lower socioeconomic classes in rural areas showed higher diastolic blood pressure (DBP) levels. Additionally, there was a linear increase in SBP concerning increasing weight and height, as presented in Table 7.

Table 7: Multi-Variate analysis of BP Distribution in relation to anthropometry.

Variables	Correlation r	Determination r^2	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

Discussion

A total of 2019 boys and girls, aged 5–16 years, were selected randomly from a total of six government and seven private upper primary and high schools. Detailed demographic and anthropometric information were collected, and blood pressure measurements, including systolic and diastolic readings, were obtained following the enclosed protocol. Subsequently, the results were analyzed. The age of the children in this study ranged from 5 to 16 years. The findings of this study indicated a consistent rise in blood pressure with advancing age in both males and females. Specifically, there was a linear increase in diastolic blood pressure from 5 to 13 years, with a slight exception at 12 years, where a small increase was observed, and at 16 years, where a decline was noticed. These fluctuations may be attributed to hormonal changes that are typical during adolescence. Additionally, at 6 years of age, diastolic blood pressure was disproportionately low in girls. Raj et al. [7] observed a relative increase in mean systolic and diastolic blood pressures in both boys and girls. However, as the participants reached the age of 16 years, minimal differences in SBP and DBP were observed between the sexes. In our study, we observed a linear correlation between mean systolic and diastolic blood pressure and height in both boys and girls. This correlation was found to be strongly positive, indicating that as height increased, so did blood increase. Narang et al. [8] observed a similar positive effect of height on SBP and DBP. However, they found that females exhibited higher SBP than males. In contrast, DBP showed a linear increase in height in both boys and girls. Another study conducted by Raj et al. [7] revealed a relatively significant correlation between height and both systolic and diastolic blood pressure.

We also noted a linear increase in systolic and diastolic blood pressures with increasing weight, and this relationship was found to be statistically significant ($p<0.001$). These findings are consistent with those of Raj et al. [7] and Narang et al. [8] BMI serves as an indicator of overall adiposity, and various consensus points or definitions are used to categorize obesity and overweight in children and adolescents. These classifications typically rely on age- and sex-specific BMI nomograms.

In our study, both systolic and diastolic blood pressure showed a significant increase ($p<0.001$) in the overweight and obese groups compared with that in children with a normal BMI. This suggests that the BMI percentile can be utilized as a predictor of high blood pressure, enabling the recommendation of preventive lifestyle modifications based on BMI alone to improve safe blood pressure levels. Similar observations were made in studies conducted by Raj et al. [7] and Narang et al. [8], where both systolic and diastolic blood pressures were higher in boys and girls in the overweight and obese groups. In addition, Taksande et al. [9] S Ramalingam et al. [10], and Durani et al. [11] also reported a positive correlation between systolic and diastolic blood pressures with BMI in their respective studies.

In our study, we found a linear increase in mean systolic and diastolic blood pressures with higher socioeconomic status, likely due to the higher average weight of children with better socioeconomic backgrounds. The p-value was found to be significant (p <0.001). Similar results were observed in studies conducted by Madhusudhan et al. [12] and Santosh Prasad et al. [13], which also showed a strong positive correlation between socioeconomic status and SBP and DBP in different socioeconomic groups. In our study, we discovered that 9.9% of the children had a family history of hypertension. Children with hypertensive parents had higher blood pressure levels than those with normotensive parents. This finding was observed in both boys and girls and was statistically significant (p<0.001), which is consistent with the results reported by Madhusudhan et al. [12]

In the current study, we observed a significant correlation (P <0.01) between systolic blood pressure and height, weight, BMI, and age. This finding is consistent with the study conducted by Durani et al. [11], which also reported a strong Pearson's correlation coefficient for systolic and diastolic blood pressure with height, weight, and BMI (P <0.01). Similarly, Taksande et al. [9] found a strong positive correlation between SBP and DBP and age and various anthropometric measurements, including height, weight, and BMI (P <0.01). In this study, we found that blood pressure increased with age, especially during adolescence. Height was also correlated with blood pressure, but its contribution was small. Simplified blood pressure tables and charts can be prepared based on age and sex. In this study, systolic blood pressure was found to be negatively correlated with age, sex, socioeconomic status, BMI, and locality. Weight and height were positively correlated with systolic blood pressure. Diastolic blood pressure was negatively correlated with sex and positively correlated with locality and social status. Weight positively correlated with diastolic blood pressure. In conclusion, blood pressure increases with age and is affected by sex, weight, height, social status, and locality.

The findings of our study were consistent with those of Narang et al. [8], who employed polynomial regression analysis and found that age, height, and weight had a positive impact on systolic blood pressure (SBP). Moreover, they observed that the female sex was associated with higher SBP and that diastolic blood pressure (DBP) showed a direct correlation with weight and waist circumference, with higher values observed in females. Similarly, in the study conducted by Raj et al. [7], a polynomial regression model was utilized to estimate blood pressure percentiles based on age, sex, and height. They also predicted blood pressure as a function of age and height Z-score for both sexes separately. Additionally, the researchers tabulated blood pressure percentiles in relation to age, sex, and height.

Conclusion

The following conclusions were drawn from the results of the present study.

- There were no significant differences in blood pressure (both systolic and diastolic) between males and females across all age groups.
- There was a linear increase in mean systolic and diastolic blood pressure with increasing age, weight, and height.
- There is a strong positive correlation between mean blood pressure (both systolic and diastolic) and BMI, as evidenced by significant Pearson's correlation coefficient and multivariable coefficient analysis (P<0.01). Obese children tend to have higher blood pressure levels for a given age.
- Children with a family history of hypertension and those belonging to high socioeconomic status (class I) exhibited increased SBP and DBP. Additionally, the mean SBP in class I SES was higher than that in class III SES, with statistical significance (P <0.001).
- The BMI percentile can serve as a predictor of high blood pressure, and thus, lifestyle modifications can be recommended based on BMI alone to improve blood pressure levels and promote better cardiovascular health.

References

1. Srinivas HA, Harisha G, Thibbegowda CD, Pushpalatha K, Susheela C. A Study of Blood Pressure Profile in Rural School Children of Kolar Taluka. Inter J Scien Study. 2014;1(5):24-8.
2. Tabassum N, Zulfia K, Khan Iqbal KM, Mohammed AA. Shaad A, FNB Blood pressure profile and its determinants: A study in adolescent school children. J. Preventive Cardiol. Feb 2015;4(3):685-91.
3. Yuvaraj. B.Y, Nagendra Gowda M. R, Rajeev. K.H., Prashanth Kumar. J. H, Santhosh Ujjanappa & Shreyas. M. A Study on Hypertension in School Children of Chitradurga. 2014;14(1):1-5.
4. Singhal V, Agal P, Kamath N. The Prevalence of Elevated Blood Pressure and the Association of Obesity in Asymptomatic Female Adolescent Offsprings of Hypertensive and Normotensive Parents. J Clin Diag Resea. 2012 Sep 1;6(7):1158-61.
5. Prineas RJ. Blood pressure in children and adolescents. In: Bulpitt CJ, 20th ed. Epidemiology of hypertension. New York: Elsevier; Birkenhager WH and Reid JL, eds. Handbook of hypertension. 2000: 86-105.
6. Bairwa M, Rajput M, Sachdeva S. Modified Kuppuswamy′s socioeconomic scale: social

researcher should include updated income criteria, 2012. Indian J Community Med. 2013;38(3):185–86.
7. Raj M, Sundaram KR, Paul M, Kumar RK. Blood pressure distribution in Indian children. Indian Pediatr. 2010 Jun 1;47(6):477-85.
8. Narang R, Saxena A, Ramakrishnan S, Dwivedi SN, Bagga A. Oscillometric blood pressure in Indian school children: Simplified percentile tables and charts. Indian Pediatr. 2015 Nov 1;52(11):939-45.
9. Taksande A, Chaturvedi P, Vilhekar K, Jain M. Distribution of blood pressure in school-going children in a rural area of Wardha district, Maharashtra, India. Ann Pediatr Cardiol. 2008;1(2):101-06.
10. Ramalingam, Sudha, Chacko, Thomas. Blood pressure distribution and its association with anthropometric measurements among Asian Indian adolescents in an urban area of Tamil Nadu. International Journal of Medical Science and Public Health. 2014; 3: 1100.
11. Durrani AM, Fatima W. Determinants of blood pressure distribution in school children. The European J Publ Health. 2012 Jun 1;22(3):369-73.
12. Kamatham Madhusudhan, Rajendra Betham, Venkateswara Rao Jampana. Study of blood pressure profile and correlation of hypertension with age, sex, anthropometric measurements (weight, height, body mass index), socio-economic status, and hereditary factors in school-going children. International Journal of Contemporary Paediatrics, 2017 Jan;4(1):19-27.
13. Santosh Prasad, Sarbil Kumari, Jairam Singh, Laxman Kumar. Community-Based study on distribution of blood pressure and its correlates among school-going children of Nalanda District. International Archives of Integrated Medicine. 2017;4(6):187-191.