Original Research Article

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Study on variation of blood-pressure in relation to posture among children aged 4-14 years

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ABSTRACT

Background: The response of blood pressure to change in body position has been used in epidemiological studies as a measure of cardiovascular reactivity. Studies had shown that the difference between the supine and seated blood pressures is positively associated with subsequent development of systemic hypertension independent of supine blood pressure. Objective of present study is to study the variation in blood pressure among children in the age group of 4-14 years in relation to the change in their posture.

Methods: A cross-sectional study was conducted in a rural area near our medical college hospital. A primary and middle school in that area was selected for our study. A total of 500 children in the age group of 4 -14 years were included in our study. Demographic profile was recorded for all children. Height, weight and BMI were measured. Blood pressure measurement was done by using the auscultation method and with appropriate sized blood pressure cuff. **Results:** The blood pressure shows a gradual increase as the age of the study subjects increases and there was no statistically significant difference in the blood pressure between males and females (p>0.05). Supine posture shows a comparatively higher systolic pressure and a lower diastolic pressure reading than the sitting and standing posture. The mean difference in systolic blood pressure between sitting and supine posture was less than the mean difference between sitting and standing and the mean difference between supine and standing, which was found to be very high and a similar type of result was also shown in the diastolic blood pressure and this mean difference between the postures was found to be statistically significant (p<0.05).

Conclusions: Postural changes in systolic and diastolic deserve further study as a potential risk factor for the development of hypertension as this could be easily measured in clinical practice and in epidemiological studies.

Keywords: Blood pressure, Posture, Rural area, Supine, Sitting and standing

INTRODUCTION

Currently we are in the phase of epidemiological transition mainly due to the change in life style and the growing economy and so we are witnessing an increase in the prevalence of obesity and high blood pressure not only in adults but also in children. The response of blood pressure to change in body position has been used in epidemiological studies as a measure of cardiovascular reactivity.

Sparrow et al studies the variation of blood pressure in different postures among the adults and finally reported that a 10-mm Hg or greater increase in diastolic blood pressure (DBP) from the supine to standing position significantly modified the effect of seated systolic blood

pressure (SBP) and DBP. On further investigation of this population, the investigators concluded that the difference between the supine and seated blood pressures is positively associated with subsequent development of systemic hypertension independent of supine blood pressure.¹

In younger people, the predominant blood pressure abnormality is a high diastolic blood pressure. The most common form of hypertension in young adults is thus isolated diastolic hypertension when classifications based mainly on middle aged and older populations are used.^{2,3} Whether blood pressure limits recommended for middle aged and older people are applicable in adolescents is unknown. Because mortality is low in adolescents, no previous population based study has been large enough to investigate relations of systolic and diastolic blood pressures to mortality in this age group.⁴

Children and adolescents are at a special growth period. Their cardiovascular development is immature and presents different features compared with adults, such as a smaller stroke volume, thinner vessel walls, larger vessel diameter and incomplete nervous system regulation.5 Their heart rates are faster and their BPs are lower than in adults. In particular, the exact changes of heart rate and BP from supine to upright are larger than in adults and the normal range of heart rate and BP varies with ages. Therefore, the diagnostic criteria for adults are sometimes not suitable for children and adolescents. In a consensus statement, Freeman et al indicated that increased heart rate should be raised by at least 40 bpm in POTS (Postural tachycardia syndrome) diagnosis orthostatic adolescents aged between 12 and 19 years.6 Singer et al reported that the 95th percentile of heart rate change was 42.9 bpm in normal children and adolescents aged between 8 and 19 years, using head-up tilt test (HUTT). However, large sample-sized evidence for the criteria of POTS in children is lacking.⁷

Differences in a person's supine, seated and standing blood pressure may provide important insights into cardiovascular status because gravitational effects of the upright position produce a significant of pooling of blood below the level of heart and produces a change in the blood pressure. Moreover, over differences between supine and upright blood pressure vary according to the ability of cardiovascular system to respond normally to postural changes. Thus, assessment of blood pressure in different positions may yield important information on regulation and control of blood pressure that a single measure might not provide. 8,9

The response of blood pressure to change in body position is well suited as a measure of cardiovascular reactivity for epidemiological studies. Several experimental studies have suggested a differential response of blood pressure to standing due to ethnicity and gender. However, other studies found no gender differences. Dijective of present study is to investigate the variation in blood

pressure among children in the age group of 4-14 years in relation to the change in their posture.

METHODS

A cross-sectional study was conducted in a rural area near our medical college hospital. A primary and middle school in that area was selected for our study. The study was carried out after obtaining the permission from the school head master and the institutional ethical committee. A total of 500 children in the age group of 4 -14 years were included in our study. Children with gross motor developmental delay who cannot sit and stand, previously diagnosed as hypertension and currently on on antihypertensives (etiologies like chronic glomerulonephritis, chronic pyelonephritis, multidysplastic kidney, reflux nephropathy, coarctation of aorta, renal artery stenosis, congenital adrenal hyperplasia, Cushing syndrome, chronic steroid therapy, etc) were excluded from the study.

Demographic profile was recorded for all children. All children were weighed on a standard electronic weighing scale for recording the weight. The height of the children was measured by making them to stand erect, heels together, chin up and a ruler was placed horizontally to rest the head and the height was recorded from a erect meter ruler placed on a flat surface against the wall. BMI was calculated by using the standard formula.

Blood pressure measurement was done by using the auscultation method and with appropriate sized blood pressure cuff. The child was made to sit quietly for 5 minutes with the back supported, feet on the floor, right arm supported and cubital fossa at heart level. Sitting blood pressure was taken from the right arm. After one minute blood pressure was measured in standing with the arm supported at the elbow and the cuff at the heart level, after one minute of rest, the blood pressure was taken in supine position. Two readings were taken for all three postures at an interval of 5 mins apart and the average of two reading was taken as the final blood pressure.

Statistical analysis

All data were entered and analysed by using SPSS version 20. For all the parametric variables mean and standard deviation was derived. Student T test and ANOVA type of statistical inference test was used to assess the statistical significant difference in blood pressure among the three different postures.

RESULTS

Table 1 shows the age and sex wise distribution of the study subjects. It is seen from the table that majority of the study population were in the age group between 7-11 years and according to gender males were slightly higher in number than the females with M:F ratio 1.15:1.

Table 1: Age and sex wise distribution of the study subjects.

Age	Gender	Total	
group	Male	Female	Total
4-6	52 (19.4%)	29 (12.5%)	81 (16.2%)
7-9	94 (35%)	84 (36.2%)	178 (35.6%)
10-11	87 (32.4%)	66 (28.4%)	153 (30.6%)
12-14	35 (13%)	53 (22.8%)	88 (17.6%)
Total	268 (100%)	232 (100%)	500 (100%)
Mean±SD	8.85±2.4	9.22±2.4	

Based on the WHO guidelines BMI of the study population was calculated by recording their height and weight. The mean BMI among males was 13.9 and of females it was 14.06 and there was no statistically significant difference in BMI between males and females as well as between different age group.

Table 2: Mean BMI among different age and sex group.

Age	Gender	P value	
group	Male	Female	r value
4-6	13.78±1.74	13.74±1.31	0.926
7-9	14.06±1.56	13.89±2.04	0.673
10-11	14.24±2.38	15.34 ± 2.84	0.0848
12-14	15.89 ± 2.32	16.68±3.24	0.295
Overall	13.91±2.18	14.06±1.89	0.319

P value derived by applying unpaired T test

Blood pressure was recorded in three different postures for the study subjects and in each posture two readings were taken and the average of two was taken for the analysis.

Table 3: Mean blood pressure among different age and sex group in sitting posture.

	Gender				P value	
Age group	Male		Female		1 value	
	Systolic BP	Diastolic BP	Systolic BP	Diastolic BP	Systolic BP	Diastolic BP
4-6	93.41±5.9	61.52±7.2	93.4±6.1	59.8±6.7	0.582	0.639
7-9	96.2±7.2	64.8±6.3	95.7±7.8	64.6±7.6	0.951	0.984
10-11	99.8±7	68.6±6.4	99.3±8.2	65.5±6.5	0.096	0.0841
12-14	101.1±7.2	68.3±7	101.3±5.3	66.2±6.7	0.873	0.0926
Overall	97.2±7.6	65.6±7.4	97.4±6.2	64.2±5.8	0.318	0.854

Table 4: Mean blood pressure among different age and sex group in standing posture.

	Gender				P value	
Age group	Male		Female		r value	
	Systolic BP	Diastolic BP	Systolic BP	Diastolic BP	Systolic BP	Diastolic BP
4-6	92.5±6.4	62.2±6.8	92.7±5.8	62±9.6	0.135	0.549
7-9	94.8±6.5	64.6±6.6	94.5±7.2	64.9±6.6	0.288	0.367
10-11	97.2±5.8	66.7±5.9	97.4±8.5	66.9±6.6	0.109	0.906
12-14	97.5±7.1	68.8±7.3	98.2±6.2	67.5±.9	0.158	0.190
Overall	93.1±7.1	66.6±7.1	93.6±8.4	65.5±7.7	0.346	0.918

Table 5: Mean blood pressure among different age and sex group in supine posture.

	Gender				D volus	
Age group	Male		Female		P value	
	Systolic BP	Diastolic BP	Systolic BP	Diastolic BP	Systolic BP	Diastolic BP
4-6	94.2±6.7	58.9±7.1	92.1±5.6	56.7±7.5	0.156	0.215
7-9	97.2±6	61.3±5.1	97.1±5.3	61.9±5.4	0.972	0.564
10-11	100.2±6.7	63.5±5	102.7±8.1	64.5±6.7	0.173	0.479
12-14	102.4±6.8	64.5±7.2	102.6±7.5	64.3±6.9	0.891	0.915
Overall	98.2±7.3	61.8±6.5	98.7±7.9	62±7.2	0.529	0.802

The mean systolic and diastolic blood pressure among different age groups and in different gender was tabulated in Table 3 and it is seen from the table that the blood pressure shows a gradual increase as the age of the study

subjects increases and there was no statistically significant difference in the blood pressure between males and females (p>0.05). Similarly, the mean systolic blood pressure was 93.1 mm hg among males in standing posture

and in females it was 93.6 mm hg and the diastolic pressure was 66.6 mm hg among males and that of females it was 65.5 mm hg and the difference was not found to be statistically significant (p>0.05) (Table 4). Systolic blood pressure in supine position was found to be the highest

among the three different postures, the mean systolic and diastolic blood pressure among males was 98.2 mm hg and 61.8 mm hg respectively and for females it was 98.7 mm hg and 62 mm hg and there was no statistically significant difference between the two gender (p>0.05) (Table 5).

Age **Systolic BP** Diastolic BP group Mean difference between Mean difference between supine and supine and sitting and sitting and sitting and sitting and P value supine standing standing supine standing standing value 4-6 3.3 < 0.0001 2.6 -3.8 < 0.0001 1.2 2.1 -6 7-9 2 1.6 2.6 < 0.001 3.5 -0.3 -3 < 0.0001 10-11 2.1 3.1 5 < 0.0001 5.3 -1.4 -2.5 < 0.001

< 0.0001

< 0.0001

3.8

4.8

Table 6: Mean difference of blood pressure in various postures among the study subjects.

BMI wise BP changes was not analysed as 90% of the children were in first percentile and the remaining 8% were in 2nd percentile and 2% in 3rd percentile. Table 6 shows the mean difference in blood pressure between various postures. Supine posture shows a comparatively higher systolic pressure and a lower diastolic pressure reading than the sitting and standing posture. The mean difference in systolic blood pressure between sitting and supine posture was less than the mean difference between sitting and standing, which was found to be very high and a similar type of result was also shown in the diastolic blood pressure and this mean difference between the postures was found to be statistically significant (p<0.05).

3

3.8

5.1

5.5

DISCUSSION

12-14

Overall

2.1

1.8

A change in body position involves change in the distribution of blood volume and a reflex change of sympathetic outflow. When a healthy person changes from supine to standing position, the circulation is affected primarily by hydrostatic factors and compensatory nervous system mechanism to maintain the blood pressure. ¹⁴ The assumption of the upright position causes a reflex arteriolar constriction and the pooling of blood in the venous system. This pooling is associated with a decrease in stroke volume and cardiac output which causes a transient drop in systemic blood pressure.

The drop in blood pressure result in baroreceptor relaxation and sympathetic stimulation which causes venous constriction and reflex acceleration of heart rate, increase in muscle tone an immediate increase in plasma catecholamines and a delayed activation of reninangiotensin aldosterone system all of which serve to stabilise cardiac output at a level lower than in the supine position. ¹⁵ Assumption of the upright position stimulates sympathetic function and inhibits parasympathetic

function. In adults it was reported that systolic pressure to be slightly reduced and diastolic pressure remains same or slightly elevated in standing position relative to supine position. However, a precise distribution of the normal response of blood pressure during orthostasis is not well documented.¹⁶

-3.2

-3.5

< 0.0001

< 0.0001

-1.3

-1.3

In our study the mean systolic was lowest in standing and highest in supine posture and similarly the mean diastolic pressure was found to be increased in standing posture and much reduced in supine posture and the difference was found to be statistically significant and a similar type of results was also shown by a study done by Grethe S Tell et al, in his study he found that there was a slight decrease in systolic pressure and a significant increase in diastolic pressure.¹⁷

Similar type of results was also published by a Japanese study and a Philadelphia study quoting a significant decrease in systolic pressure while standing from supine posture and significant increase in diastolic pressure from supine to standing posture. ^{18,19} Whereas a study done by Jorde and Williams on white adolescents in the age group of 12-18 years found that systolic pressure did not show significant decrease from supine to standing posture whereas the diastolic pressure showed a significant increase from supine to standing posture. ²⁰

The response to postural change was similar in men and women, as seen in a previous study.²¹ These findings are also supported by MacLennan et al, who found no significant difference in the prevalence of postural hypotension between men and women.²² However, other studies reported a gender difference in the blood pressure response to standing.^{23,24} Our study was conducted at the community level, as a clinic or a hospital setting can be a stressor itself and may artificially increase blood pressure and blood pressure reactivity.

CONCLUSION

The current epidemiological study had shown a significant change in the blood pressure with relation to the change in the posture. The response of blood pressure to change in posture may serve as a tool at the population level for measuring a variety of mechanisms related to cardiovascular morbidity.

More number of multi-centric and prospective studies would help in the detection of hypertension at an earlier stage and an immediate intervention would certainly prevent major cardiovascular diseases. Postural changes in systolic and diastolic deserve further study as a potential risk factor for the development of hypertension as this could be easily measured in clinical practice and in epidemiological studies.

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Conflict of interest: None declared

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Institutional Ethics Committee

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