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UPPER BODY FAT MARKER: AN USEFUL SCREENING TOOL OF HYPERTENSIVE RISK IN SCHOOL GOING ADOLESCENT BOYS

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ABSTRACT

Background: Elevated blood pressure (BP) during childhood is an established predictor of cardiovascular disease in adulthood. High blood pressure in childhood commonly leads to hypertension (HT) in adulthood. Thus early identification of risk factors for high blood pressure in children is essential. **Objective**: The aims of this study were to evaluate the role of upper body fat marker, neck circumference (NC) as an independent predictor of hypertension and to compare it with traditional indices like general and central obesity. **Methods**: The study was carried out in semi-urban school boys aged 10-14 years. General obesity was estimated from body mass index (BMI), central obesity from waist circumference (WC) and waist-to-height ratio (WHtR) and upper body fat from neck circumference (NC) and neck to height ratio (NHtR). Body height, weight, waist circumference, neck circumference and blood pressure were measured. BMI, WHtR and NHtR were calculated. Percentile of NC and NHtR and prevalence of hypertension were determined. **Results**: Blood pressure was significantly correlated with BMI, WC, WHtR, NC and NHtR. Positive correlation was also noted between Upper body fat marker and general obesity and central obesity. Association between NC and hypertension is comparable with those observed for general and central obesity. Significant association was also noted between high upper body fat and hypertension. NC above 32cm and NHtR above 0.223 were the best values for identifying hypertension in adolescent boys. **Conclusion**: NC and NHtR, upper body fat markers are good predictor of childhood hypertension, a most important cardiovascular risk factor. Measurement of NC is simple and time saving and done more accurately in compare to measurement of WC. Thus upper body fat markers could be a simple surrogate anthropometrical screening tool of hypertensive risk of adolescent boys.

KEYWORDS: Neck circumference, Hypertension, Adolescent, central obesity, general obesity.

INTRODUCTION

Hypertension is the commonest non communicable disease affecting both sexes in all races.[1] It places the affected individuals at an increased risk of cardiovascular accident, ischemic heart disease and renal failure.[2] This disease is a silent threat to the health of people all over the world. Around one billion adult world population was found to have HT in the year 2000 and this is expected to increase to 1.56 billion by 2025.[3,4] Hypertension in children and adolescent is a growing health problem.[5] High blood pressure in childhood commonly leads to hypertension in adulthood.[6] The development of hypertension in younger age causes greater reduction of life expectancy if the blood pressure is left untreated.[7] It has also been noted that even asymptomatic adolescents with blood pressure elevation can have target organ damage including left ventricular hypertrophy and pathological vascular changes.[8,9]

Obesity is rising to pandemic proportions and is an important risk factor for cardiometabolic disease including diabetes, hypertension and coronary heart disease.[10] The distribution of excess body fat play an essential role in the development of cardiovascular risk factors.[10] Visceral fat, upper body subcutaneous fat and lower body fat exert an independent effect toward for the development of cardiovascular risk.[11] General obesity was measured by BMI but it restricted in screening regional body fat distribution. WC is superior to BMI in identifying central adiposity reflecting higher cardiovascular risk.[12] Neck circumference (NC) has been suggested as an index of upper body fat distribution.[13] Moreover, NC measurement is simple and time saving to identify overweight and obesity.[13] High NC is cardiovascular risk factor in adults.[14,15] However, few epidemiological studies have examined the association between high NC and high blood pressure in children and adolescent.[15]

The high prevalence of increased BP or hypertension is a serious public health problem in children, adolescent and adult population.[16] Therefore it is essential to evaluate simple and easily detectable risk factor for an early identification of subjects who can be at an increased risk for cardio vascular diseases. Moreover, the association between high NC and prehypertension and/or hypertension have not been studied among Bengali Indian children and adolescent before. The aim of this study was to evaluate the association between neck circumference (NC) and high BP in adolescent and to compare it with well-established anthropometrical indices like general and central obesity.

METHODS

***Subject*:** The present study was conducted among normal healthy school boys of 10-14 years of four boys' school in Hooghly district of West Bengal state during their school hours. The prior written permission of school authority was taken. Written consent from the parents of the students experimented in the study was obtained. 502 students were included in this study. Every child in this study was given a predesigned questionnaire which was recorded by either parents to obtain the information with reference to their last blood pressure readings, family history of hypertension, myocardial infarction and/or stroke, food habit and physical activity.

***Measurement of blood pressure*:** Blood pressure was measured with a standard mercury sphygmomanometer. Before recording the blood pressure students were allowed to wait in separate room for 10 minutes to relieve their restlessness and anxiety. Each boy was then called one by one and pressure was measured in the sitting posture in the right upper arm. Three readings were taken at 5 minute intervals and their mean was taken as subject's blood pressure. The child cuff was used when upper arm length was 20cm or less and the adult cuff otherwise.[17] Systolic blood pressure was recorded on hearing the first sound (phase I) while diastolic blood pressure was taken on complete disappearance of Korrotkov sounds (phase V). Normotensive, pre hypertensive and hypertensive status of blood pressure were estimated by considering National high blood pressure education program, 2005.[18]

Anthropometric measurements: Prior to the weight and height measurement subjects were asked to remove their shoes and heavy clothing. Body weight was measured using bathroom scale accurate to 0.5kg. The scale was kept on a flat surface and adjusted with '0' mark. Now the subject was requested to step on it in bare feet. Weight was recorded to the nearest 0.5kg.

For the measurement of height and NC subjects were asked to stand still and quiet and erect position. , hanging their arms freely and keeping their head aligned in the Frankfort plane. Two measurements were recorded to the nearest 0.1 cm for each subject. Height was measured using anthropometric rod. NC was measured just below the laryngeal prominence (Adam's apple) using calibrated plastic tape [10]. WC was measured mid-way between iliac crest and lowermost margin of the ribs in quiet breathing using plastic tape [10]. WC above 90th percentile was considered as centrally obese.

Waist- height- ratio was calculated by dividing waist circumference with height. Similarly neck-height-ratio was calculated using following equation: NHtR= NC (cm) / Height (cm). BMI was calculated from the height and weight using following equation: BMI (kg/m^2) = weight (kg) / height^2 (m). BMI below 85th percentile was considered as normal; in between 85th to 95th percentile was considered as overweight and BMI above 95th percentile was considered as obese.

***Statistical analysis*:** Data obtained from the study were given as mean ± SD. The statistical significance was determined by student's t test. Two tailed p values were used throughout and p value less than 0.05 were judged as statistically significant. Pearson's correlation coefficient was calculated to find out the degree and direction of association between two parameters.

RESULTS

The study sample comprised 349 children having 10-14 years old who had complete anthropometric measurements and blood pressure estimation. The characteristic of study sample are presented in table-1.

Table 1: Characteristic of study population.

Parameters	Mean value ± standard deviation
Age (year)	11.70 ± 1.41
Height (cm)	140.98 ± 10.22
Weight (kg)	34.82 ± 9.61
Neck circumference (cm)	28.30 ± 2.69
Waist circumference (cm)	62.42 ± 9.82
BMI (kg/m^2)	17.27 ± 3.89
Neck-to-height-ratio	0.201 ± 0.017
Waist-to-height-ratio	0.443 ± 0.063
Systolic blood pressure (mm Hg)	105.50 ± 15.11
Diastolic blood pressure (mm Hg)	67.63 ± 11.99

Blood pressure status of study subjects were presented in fig-1. 17% of study population were hypertensive.

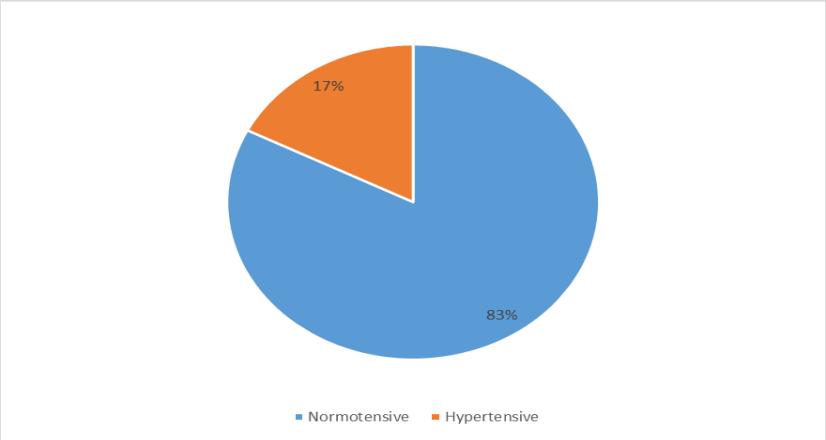

Fig.1: Distribution of subjects on the basis of blood pressure status.

Correlation between BP and anthropometric parameters were given in table-2. Significant positive correlation was observed between BP and anthropometric parameters. Degree of association with systolic blood pressure was more than diastolic blood pressure in all cases.

Table 2: Correlation between various anthropometric parameters and blood pressure.

Anthropometric parameters	Systolic blood pressure	Diastolic blood pressure
Neck circumference (cm)	+ 0.498	+ 0.343
Waist circumference (cm)	+ 0.539	+ 0.411
BMI (kg/m^2)	+ 0.489	+ 0.418
Neck-to-height ratio	+ 0.323	+ 0.319
Waist-to-height ratio	+ 0.448	+ 0.409

Pearson's correlation coefficient calculated. P<0.001for all the cases

Association between Upper body fat marker (NC and NHtR) and other tested anthropometric parameters were evaluated and represented in table-3. A significant positive correlation was noted between Upper body fat markers and general obesity and central obesity.

Table 3: Relation between anthropometric indices in adolescent boys.

Parameters	NC	WC	NHtR	WHtR	BMI
NC	1	0.734	0.684	0.588	0.812
WC	0.734	1	0.578	0.890	0.827
NHtR	0.684	0.578	1	0.662	0.664
WHtR	0.558	0.890	0.662	1	0.749
BMI	0.812	0.827	0.664	0.749	1

Study subjects were divided into four subgroups based on NC percentile as well as on NHtR percentile. In both the cases individuals in the highest percentile of NC and NHtR had significantly greater general obesity, central obesity and hypertension. Subjects with above 90th percentile NC, 23.55% were overweight, 55.9% obese, 58.8% centrally obese and 55.9% were hypertensive (table-4). Like NC similar pattern of results were obtained for NHtR (table-5). Thus both the markers (NC and NHtR) were significantly associated with childhood hypertension.

Table 4: Anthropometric characteristic and blood pressure status of study subjects as per the distribution of neck circumference.

Parameters	Neck circumference			
	<25th (<26.5 cm) [n=81]	25-75th (26.5 to 29.5 cm) [n= 184]	>75-90th (>29.5 to 32.0cm) [n=50]	>90th (>32 [n=34]
Age	11.0 ± 1.49	11.8 ± 1.29	12.3 ± 1.12	12.0 ± 1.37
Normal weight	81(100%)	179 (97.3%)	31 (62%)	7 (20.6%)
Over weight	0	4 (2.2%)	18 (36%)	8 (23.5%)
Obese	0	1 (0.5%)	1(2%)	19 (55.9%)
Central obesity	0	1 (0.5%)	11 (22%)	20 (58.8%)
Hypertension	7 (8.6%)	22 (12.0%)	13 (26.0%)	19 (55.9%)

Table 5: Anthropometric characteristic and blood pressure status of study subjects as per the distribution of neck-to-height ratio.

Parameters	Neck-to-height ratio			
	<25th (<0.189) [n=84]	25-75th (0.189 to 0.209) [n= 178]	>75-90th (>0.209 to 0.223) [n=52]	>90th (>0.223 [n=35]
Age	12.0 ± 1.49	11.7 ± 1.29	11.2 ± 1.12	11.6 ± 1.37
Normal weight	82 (97.6%)	167 (93.8%)	38 (73.0%)	11 (31.4%)
Over weight	2 (2.4%)	8 (4.5%)	13 (25.0%)	12 (34.3%)
Obese	0	3 (1.7%)	1 (1.92%)	12 (34.3%)
Central obesity	1 (1.2%)	8 (4.5%)	6 (11.5%)	16 (45.7%)
Hypertension	8 (9.5%)	26 (14.6%)	11 (21.2%)	16 (45.7%)

DISCUSSION

NC is an index of upper body subcutaneous adipose tissue distribution. It was investigated as a screening tool for overweight individual.[19] It is significantly correlated with BMI (table-3). Various studies also supports NC as a potential indicator of overweight and obesity.[20,21] NC is significantly correlated with indexes of central obesity like waist circumference and waist to height ratio (table-3). Result of this study support previous observation.[22] NHtR has also been suggested to be a measure of upper body adiposity like NC.[23] NHtR adjusts for the difference in NC attributable to differences in height. Thus it has the advantage over NC. Like NC it is significantly correlated with BMI, WC and WHtR (table-3). Data on the evaluation of upper body fat indices as predictor of childhood hypertension is scant from India.

General and central obesity are established risk factor of cardio vascular diseases including hypertension.[10] Like general and central obesity indices NC and NHtR is significantly correlated with both systolic and diastolic blood pressure. Similar result was noted by Kuciene et.al [24] on their study on Lithuanian school children. Moreover, the study populations of the present was ethnically different from other studies.

55.9% children with high NC (above 90th percentile value) were hypertensive. Hypertensive prevalence was 45.7% for children having NHtR above 90th percentile value. Thus high upper body fat may be a risk factor of high blood pressure in adolescents. NC above 32 cm and NHtR above 0.223 were the best values for identifying hypertension in adolescent boys.

High blood pressure in children and adolescent is a growing problem in the world. Early detection of risk factor of hypertension is essential to minimize cardiovascular disease in adults. Neck circumference may be a useful screening tool for hypertension as it is easy to measure, inexpensive, noninvasive and unlike waist it does not show variations throughout the day. NC measurement also has distinct cultural advantages. Due to cultural inhibitions measurement of waist and hip circumference in females is cumbersome. In contrast measurement of NC is simple.

CONCLUSION

Measurement of NC is easy, inexpensive and noninvasive. Unlike the measurement of WC, It can be measure at any time of the day. NC measurement also has cultural advantages in India in compare to measurement of WC. Upper body fat markers, NC as well as NHtR are useful for prediction of childhood hypertension especially for large scale epidemiological studies. Further studies are needed to explore the association of upper body fat markers and hypertension with large number of sample including populations other than Indian.

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