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Original Research Article

TO ASSESS THE ASSOCIATION OF BODY MASS INDEX AND WAIST CIRCUMFERENCES WITH HYPERTENSION AMONGST SCHOOL GOING CHILDREN: AN PROSPECTIVE STUDY

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ABSTRACT

Background: Hypertension is one of the most common diseases world-wide and the prevalence in school-aged children appears to be increasing perhaps as a result of increased prevalence of obesity. Body mass index (BMI) and waist circumference (WC) are commonly used indices to assess obesity. Hence this study was undertaken to study the effect of body mass index and waist circumference on blood pressure. **Methods:** A total of 500 children aged 5-16 years who completed both anthropometric and BP measurements were studied. Height, weight, body mass index, waist circumference and blood pressure were recorded. **Results:** SBP and DBP were found to be higher in children with high BMI (>85th percentile) and high WC (>90th percentile) groups. Waist circumference and BMI are strongly associated with both SBP and DBP ($p< 0.001$). **Conclusions:** Obesity indicators such as WC and BMI because of their ease of measurement can be used as a screening tool to identify children with high BP. Therefore, we suggest measurement of WC as a screening tool for childhood hypertension.

INTRODUCTION

Hypertension is a known risk factor for coronary artery disease (CAD) in adults and the presence of childhood hypertension contributes to the early development of CAD. According to many studies performed world-wide the prevalence of hypertension in children and adolescents appear to be increasing.[1]

WHO has called obesity a "Global Epidemic".[2] Hypertension in children is increasing along with the childhood obesity epidemic. Childhood obesity may persist into adulthood and hence this may increase the risk of cardiovascular disease (CVD) later in life including hypertension and metabolic syndrome.[3] In addition, childhood obesity is associated with high risk of adult hypertension.[4]

Blood pressure measurement is not apart of regular health check -ups in children and this leads to under diagnosis of hypertension in children.[5] Thus, the prevention of obesity in childhood may be important in reducing the risk of CVD later in life. The growing prevalence of hypertension is coupled with increase body weight and many reports have shown an association between blood pressure (BP) and body mass index (BMI).[6,7]

In Bogalusa Heart Study, it was reported that overweight children were 4.5 and 2.4 times likely to have elevated systolic blood pressure (SBP) and diastolic blood pressure (DBP) respectively.[8]

Body mass index (BMI) and waist circumference (WC) are commonly used indices to assess obesity. Considering that adiposity and fat distribution may be more strongly associated with CVD than simple body mass, and that WC reflects central adiposity, WC can be suggested to be a better indicator of CVD risk such as high BP, than BMI, which reflects both lean and fat mass.[9] Waist circumference (WC) as a visceral fat indicator has already been well explored in the adult population and has more recently been identified as a risk factor in children and adolescents.[10]

Evidences suggest the importance of measuring abdominal obesity besides general obesity for the evaluation of health risks in the first decades of life.[11] However, whether WC measured in childhood correlates better with high BP than BMI is still unresolved.[12]

Thus, the present study was planned to establish an association between body mass index (BMI) and waist circumference (WC) with hypertension

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amongst school children in the age group of 5-16 years.

MATERIALS AND METHODS

A cross-sectional study was conducted a part of regular health examination in different public & government schools of Dungarpur, Rajasthan, India. A total of 500 children aged 5-16 years who completed both anthropometric and BP measurements were studied. Weight, height, waist circumference and BP measurements were recorded. Weight was measured to the nearest 0.5 kg using electronic weighing scale, with the subjects wearing lightweight gown or underwear. Height was measured to the nearest 0.1 cm using wall mounted height board. Child stood straight with no shoes; heels, buttocks, shoulder blades and back of head touching the vertical wall surface and looking directly forwards with Frankfurt plane (the line joining floor of external auditory meatus to the lower margin of orbit) and the being horizontal.

BMI was calculated using standard formula: weight (kilograms)/height (meters^2). According to BMI, children were categorized into 3 groups: normal weight, overweight and obese as per World Health Organization (WHO) child growth standards (BMI greater than 95th percentile obese; BMI between 85th and 95th percentile -overweight).

Waist circumference was measured to the nearest 0.1 cm with nonelastic flexible tape with child standing with clothes. The smallest circumference between the hip and chest was measured at the end of gentle expiration. The following anatomical landmarks were used: laterally, midway between the lowest portion of the rib cage and iliac crest, and anteriorly midway between the xiphoid process of the sternum and the umbilicus. According to WC, children were divided into two groups (normal and high WC) using 90th percentile as cut-off for "high WC."

BP was measured by auscultatory method using a mercury sphygmomanometer and appropriately sized cuff (bladder width of approximately 40% of arm circumference midway between olecranon and acromion; inflatable bladder covering at least two thirds of upper arm length and 80-100% of its circumference). We measured BP after 5-10 minutes of quiet rest with the subjects seated and the right arm positioned at the level of the heart. To avoid the effects of white coat hypertension, blood pressure was measured twice on each occasion and blood pressure value was taken as the mean of the two measurements. The first and fifth Korotkoff sounds were recorded as the systolic and diastolic blood pressure.[13] Average systolic blood pressure (SBP)and/or diastolic blood pressure ≥90th percentile for age, sex and height was defined as cut off for "high SBP" and "high DBP," respectively. [14]

Statistical analysis:

Data was analysed with the software Statistical Package for the Social Science 20.0 (SPSS 20.0). The non-paired Student t –test was used. Values were expressed as mean ± standard deviation. P values <0.05 indicated statistical significance.

RESULTS

The present study included 500 school going students aged 5–16 years (290 boys and 210 girls). Out of these children, 32.8 % (164/500) had normal BMI, 44.2% (221/500) were overweight and 23% (115/500) were obese. 30.4% (152/500) children had high waist circumference and 69.6% (348/500) had normal waist circumference (table 1).

SBP was more in children with high waist circumference (115.28±8.26) than in children with normal waist circumference (109.55±6.80). DBP also showed greater values in children with high waist circumference (71.34±5.35) than in children with normal waist circumference (68.10±3.32). Thus, we found that waist circumference has strong association with both SBP and DBP (p< 0.001) (Table 1).

SBP in obese (114.24±7.42) and overweight children (112.14±7.5) was greater than in children with normal BMI (108.96±7.54). DBP was also higher in overweight (70.16±4.09) and obese (70.28±4.73) than in children with normal BMI (66.24±3.76). Hence, BMI showed strong association with both SBP and DBP (p <0.001) (table 2).

Our study showed that high BMI and high WC significantly increase the incidence of high SBP and DBP (>90th percentile) and are good predictors of rise in SBP and DBP.

Table 1: Comparison of blood pressure in children with normal and high waist circumference

Parameter	High WC(N=152)	Normal WC waist (N=348)	p value
Age (yrs)	12.36±1.75	12.78±1.67	>0.05
Weight (Kg)	56.9±5.34	45.57±10.52	<0.001*
Height (cm)	150.23±8.76	149.24±8.93	>0.05
BMI (Kg/m2)	27.38±2.64	20.36±4.2	<0.0016
SBP (mm of Hg)	115.28±8.26	109.55±6.80	<0.001*
DBP (mm of Hg)	71.34±5.35	68.10±3.32	<0.001*

Table 2: Comparison of blood pressure in children with normal BMI and obese children

Parameter	Normal BMI (N=164)	Obese (N=115)	p value	Overweight children (N=221)	p value
Age	12.21±2.02	12.17±1.70	>0.05	12.32±1.76	>0.05
Weight	35.65±5.76	64.96±4.34	<0.001*	56.62±7.12	<0.001*
Height	145.87±8.64	150.88±8.48	<0.001*	151.75±8.73	<0.001*

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SBP	108.96±7.54	114.24±7.42	<0.001*	112.14±7.5	<0.05*
DBP	66.24±3.76	70.28±4.73	<0.001*	70.16±4.09	<0.05*

DISCUSSION

Hypertension has a multifactorial etiology with functional and morphological abnormalities of vessel walls. Genetic composition, age, dietary habits, level of physical activity, personality, and personal habits are epidemiological drivers of hypertension among adults.[15] In India, it has been noted that children are on the verge of obesity associated elevated BP.[16] It has been known that BP tracks over time; children with increased values are now at an elevated chance of acquiring hypertension in older age group".[17] "BP readings for children require trained doctors to identify and take out the appropriate values. Childhood obesity demands medical attention due to increasing prevalence worldwide and its long-term consequences in adulthood. BMI and WC are commonly used indices of obesity. Numerous studies have reported positive correlations between high BMI, high WC and elevated SBP and DBP in children and adolescents.[18-20] In adults, it has been shown that central distribution of body fat is closely associated with adverse cardiovascular outcomes. However, this has not been proven in children or adolescents so far.

In a study by Bin Chen et al among preschool children, systolic BP and diastolic BP were significantly higher in obese children than that in normal weight children in both sexes (p<0.001). Overweight children had significantly higher systolic and diastolic BP than normal weight children in boys (p<0.01).[21] Wang WJ et al studied relationship of body mass index and blood pressure in 7 -15 years old children and adolescents of Beijing and found means of SBP and DBP to be significantly higher in obesity group than overweight, while overweight was significantly higher than normal weight group (P <0.0001).[22]

In a study by Rao S et al among adolescents (age range 9- 16 years) in Pune, mean level of SBP among overweight children was significantly (P<0.001) higher by about 12 mm Hg, whereas that for diastolic blood pressure was higher by 8 mm Hg (P<0.001) as compared to their non- overweight (age, sex matched) counterparts.[23] Gupta AK et al conducted study in 3,861 school children in the age group 5-15 years, among which 292 were obese. He found out that the mean blood pressure levels, both systolic and diastolic, were significantly higher in the obese subjects compared to the controls (p< 0.001). Out of 292, 10 were detected to have sustained elevations in BP levels (BP greater than mean + 2 SD for age & sex) on monthly follow up for 6 months.[24]

In the present study, statistically significant association was found between BP and anthropometric measurements such as WC and BMI in adolescent children. The children with higher body weight had higher SBP and DBP, similar results reported in many other studies: Kapil, et al[25], Jain B, et al[26] and Wang, Q, et al[27]. These results indicate that children with normal weight, but with abdominal obesity should be screened for risk of high BP because alone, BMI may not provide sufficient sensitivity to identify risk of hypertension. Thus, the measurement of WC should be seen as an additional tool for analysis of BMI to help identify high BP among children.

CONCLUSION

There was a strong correlation noted between increased WC and BMI with high BP among adolescents. Blood pressure measurement requires greater operator skill and blood pressure is liable to be falsely elevated unless measured with care and in stress free situations. WC is much easier to measure than blood pressure in terms of training and access to equipment, especially in low-income settings. Therefore, we suggest measurement of WC as a screening tool for childhood hypertension.

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