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ASSOCIATION OF BLOOD PRESSURE WITH BODY MASS INDEX AND WAIST CIRCUMFERENCE AND ITS EFFECTS AMONG SCHOOL STUDENTS (AGED 8 - 16 YEARS) OF RURAL WEST BENGAL, INDIA

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ABSTRACT

Body mass index (BMI) and waist circumference (WC) are considered as the most important anthropometric indicators to investigate the risk factors for cardiovascular diseases, hypertension and other obesity-related diseases. This study assessed the relationship between blood pressure (BP) with BMI and WC in students (aged 8 - 16 years) of rural West Bengal (WB) in Eastern India. About 551 rural secondary school going students were surveyed for BP, height, weight and WC. Among them 283 were boys and 268 were girls. BMI was derived using standard formula; Pearsons' correlation coefficient was done to assess the degree of correlation among BP with BMI and WC. A lower range of obesity was found in rural areas in both boys and girls. WC was found to be more correlated with BP than BMI. Increase of BP was found with a higher BMI and WC. Prevalence of higher BP was found among school boys than girls in rural WB.

Key words: Blood pressure, Body mass index, Waist circumference, Obesity-related diseases, Coronary heart diseases

INTRODUCTION

Globalization led the standard of living to rise particularly in developing countries. This resulted to weight gain and obesity, especially central adiposity, which are posing a threat to the health of citizens. Obesity is considered as the most prevalent form of malnutrition especially in developing countries, both in adults and children.

Studies demonstrated that obesity is very much related to elevate systolic BP (SBP) and diastolic BP (DBP) (Freedman and Perry 2000). Greater accumulation of body fat in abdominal region is the main determinant of obesity related diseases like coronary heart diseases (CHDs), cardiovascular diseases (CVDs), hypertension, diabetes etc. CT scan, MRI can detect the abdominal fat or central obesity but being very expensive, the anthropometric measurements are considered as most reliable methods (Seidell *et al.* 2001) to reveal the health problems by studying the correlations of BP with the most important central obesity indicators; basal metabolic rate (BMI) and waist circumference

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(WC). Those two have been the subject of much epidemiological and pathophysiological research involving obesity and health outcomes. BMI may not be adequate in describing the relationship between obesity and diseases (Fujimoto and Bergstrom 1995). Again, WC only reflects abdominal fat and not so much influenced by height (Lean, Han and Seidell 1998). Moreover, WC correlates with measures of risk for CHD (Kopelman *et al*. 2000). BMI is most widely used to estimate the prevalence of overweight or underweight within a population. Positive association of BMI and BP was been reported among Asian populations. India in a process of rapid economic development and changing modern life style factors has an increasing trend of hypertension (Srikanth *et al.* 2011). It is important to have data on the characteristics and health of a population because of the ethnic differences to detect health consequences and to find out individuals and populations at risk. The present study was undertaken to examine the prevalence of overweight including obesity among school students (aged 8 - 16 years) of rural WB on the basis of BMI and WC to analyze the relation between anthropometric indicators and BP. There are many studies worldwide on the association between BMI and BP.

MATERIALS AND METHODS

A cross sectional study has been done during June, 2012 to September, 2013 among school going boys and girls from lower to middle socio-economic class (Dudala *et al.* 2014) of age range 8 - 16 in 4 secondary schools of rural southern WB of Eastern India. Ages were verified from respective school records. Anthropometric measurements of 551 rural school-going subjects (283 boys and 268 girls considering PCI) were taken from a total of 690 students selected. The values of anthropometric measurements such as weight, height and WC were recorded for every subject in the study sample, indices like BMI is derived (Hu *et al.* 2002). Age and sex break-up were studied and compared with the World Health Organisation (WHO) standards (WHO 2007). Correlations among age, sex and anthropometric parameters were considered individually to derive their patterns of growth. Statistical analysis was done. Information was collected after an interview with the help of a semi structured questionnaire. The university ethical committee approved the study manner proposal, as well as the manner in which informed consent was obtained from subjects. Authors have followed the principles outlined in the declarations of Helsinki of the World Medical Association. Students between the age group of 8 to 16 were selected because in the new generation subjects who were born after 2000 AD, age of adolescence has shifted from 10 to 8 years (Hagen *et al.* 2014). The logic behind limiting the upper age boundary of the subjects’ to 16 years as secondary school students’ up to class ten (X) commonly falls within this age. Only healthy subjects were included (without any physical deformities). Students belonging to upper (S.E.) classes were not considered for this survey.

Anthropometric measurements were conducted twice on the same day for each student in same session to avoid technical errors with criterion accredited by the International Society for the Advancement of Kinanthropometry in anthropometry. Method described in the manual was followed for taking all the measurements (Brožek *et al.* 1963).

(i) Height was measured with an anthropometric rod (GPS) up to 1 mm (Esrey *et al.* 1996).

(ii) Weight (body mass) was calculated in minimal clothing. The subject stood on the centre position of the scales without support with the weight distributed evenly on both feet. Weight was taken with a digital scale (calibrated beforehand, capacity 150 kg) having a precision of 0.5 kg. Time of taking weight was also noted (Waterlow *et al.* 1972).

(iii) BMI was derived by dividing weight (kg) by height (m) squared. BMI categories were based on age specific cut-offs in adolescents. World Health Organization (WHO) based classification for global database on body mass index (BMI) was used as a cut points for BMI (Gallagher *et al.* 1996).

(iv) WC is the narrowest point of the abdomen between the lower costal border and the top of the iliac crest, perpendicular to the long axis to the trunk, was measured with a flexible and non-stretchable measuring tape. The measuring tape is to be held firmly, ensuring its horizontal position. The tape position should be horizontal all around the waist and loose enough to allow the observer to place one finger between the tape and the subject's body (Visscher *et al.* 2001).

The physiometric variables for measurement were systolic BP (SBP) and diastolic BP (DBP). Two consecutive readings of SBP and DBP were recorded and the averages were taken for study. BP was measured with the help of sphygmomanometer in a sitting position with the right forearm placed horizontally on a table. A cuff was fitted on the subject's upper arm and inflated to about 20 mm Hg. The pressure within the cuff was then released at a rate of above the 2 mm Hg/second (approx.), while osculating with a stethoscope placed over the brachial artery. The onset of sound (known as Korotkoff-phase I) was the indicator of systolic BP (SBP) and the disappearance of sound (Korotkoff-phase V) was the indicator of diastolic BP (DBP). Korotkoff phase is recommended by the American Heart Association and others (Londe and Goldring 1976). Factors affecting BP like anxiety, fear, stress, laughing and other such activities were tried to minimize (Badaruddoza and Afzal 2000). Mean arterial BP (MAP) was calculated for each of the two readings taken for SBP and DBP by using the formula: MAP = DBP + (SBP-DBP)/3.[2]

Technical error measurement (TEM) was computed and found to be within limits. Therefore TEM were not incorporated in statistical analysis. TEM was calculated as = sq root of {(sum of D^2)/2N}; where D = difference between two measurements, N = number of subjects measured.

RESULTS AND DISCUSSION

Central obesity (CO) is the most consistent risk factor for hypertension (Mukhopadhyay *et al.* 2005). It exhibits a greater tendency of central obesity in girls than boys (Dasgupta and Hazra 1999). Significant sex differences in central obesity was found among young Punjabi students in Chandigarh, North India (Goran and Malina 1999). Sexual dimorphism existed in central obesity, irrespective of the level of overall adiposity (BMI) (Guagnano *et al.* 2001). The WC seems to have a strong association with the risk of hypertension. WC is considered as the most important anthropometric factor associated with the hypertensive risk (Siani *et al.* 2002).

Table 1. Pearson correlation coefficient (*r*) of BMI and WC with respect to BP.

Index	Boys			Girls		
	SBP	DBP	MAP	SBP	DBP	MAP
BMI[a]	0.23*	0.33*	0.51	0.24*	0.21	0.09
WC[b]	0.41**	0.12*	0.12	0.4**	0.29	0.51*

**r value significant at the 0.01 level; *r value significant at the 0.05 level.

[a]BMI = Basal metabolic rate; [b] WC = Waist circumference.

BMI and WC are very much associated with BP. In Table 1, correlations reveal the fact that BMI and WC were highly correlated to BP. WC was the anthropometric index best correlated with BP than BMI. A central distribution of body fat is associated with increased BP, independently of body mass index. The WC seems to have a strong association with the risk of hypertension, principally by the ambulatory BP monitoring, when compared with casual BP measurement. Elevated BP in children was also associated with WC. Not only is WC easier to measure than BP, it also provides important information on metabolic risk (Choy *et al.* 2011). WC correlates better with visceral adipose tissue and is a better predictor of cardiovascular disease than are BMI and waist-to-hip ratio (Okosun *et al.* 1998). Mean values of all the measurements, that is, height, weight, SBP, and DBP were higher among boys as compared with girls. There was a significant positive correlation between BMI and BP, both SBP as well as DBP ratio (Okosun *et al.* 1998).

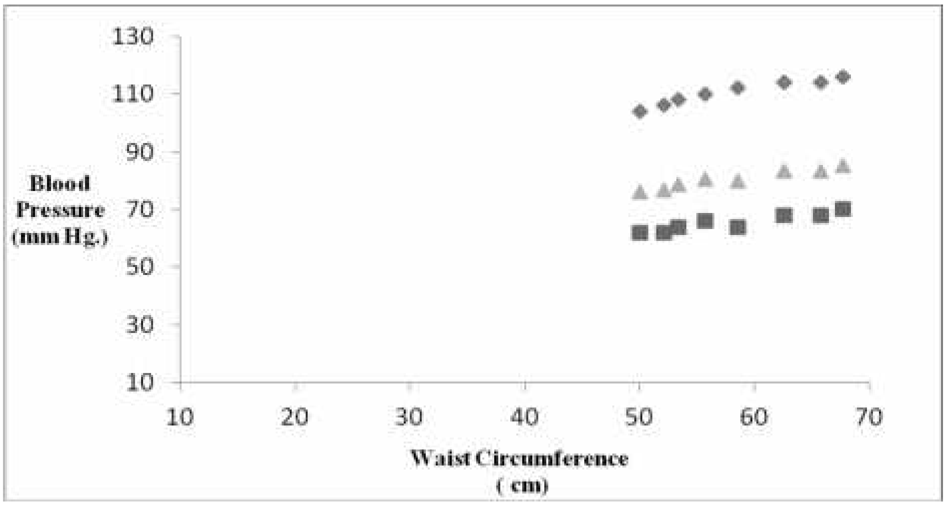

Fig. 1. Relationship of blood Pressure and waist circumference in boys.

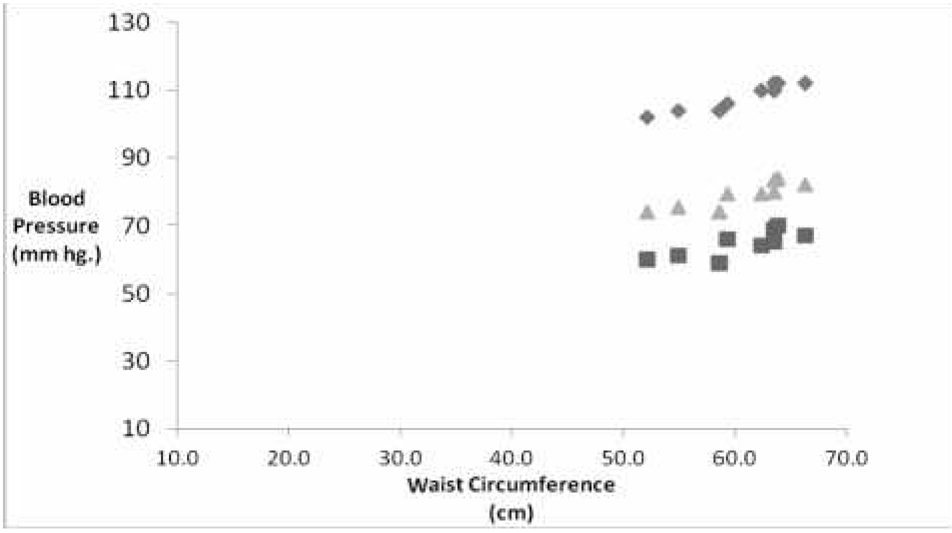

Fig. 2. Relationship of blood pressure and waist circumference in girls.

Figs 1 and 2 revealed that BP is positively correlated to WC in both boys and girls (higher in boys), which is a strong indicator of central obesity. Overweight people generally exhibit a higher BP. Age was found positively correlated with BP (both SBP and DBP). The relationship between BP and age was found to be significant and was stronger in boys than girls in the present study. Many studies have found the relationship between BP and age (both SBP and DBP) to be significant among both boys and girls (Weiner and Lourie 1981). In general, BP rises as people get older. Age is known as a risk factor for high BP (Jervase *et al.* 2009). Both SBP and DBP were found to be significantly higher among boys as compared with girls in the present study. Gender differences in BP are usually detectable during adolescence and persist through the adulthood.

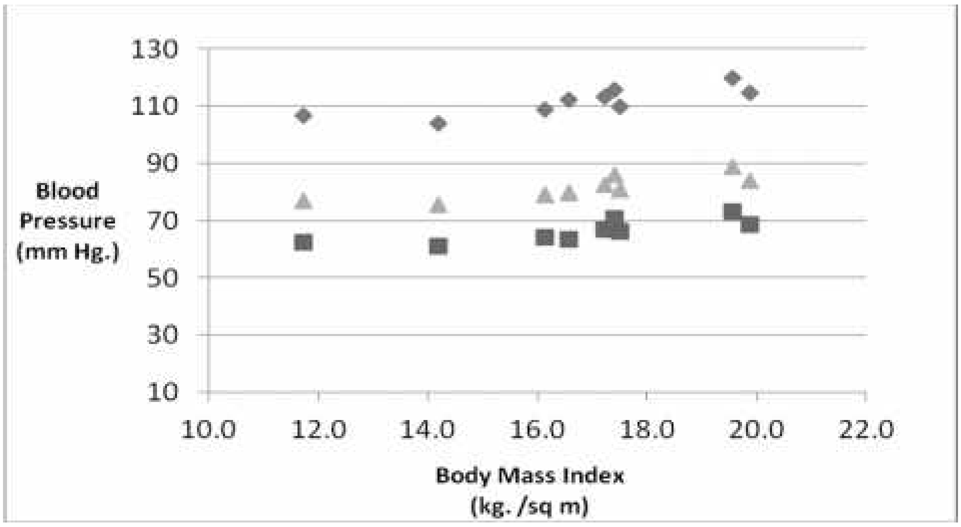

Fig. 3. Relationship of blood pressure and body mass index in boys.

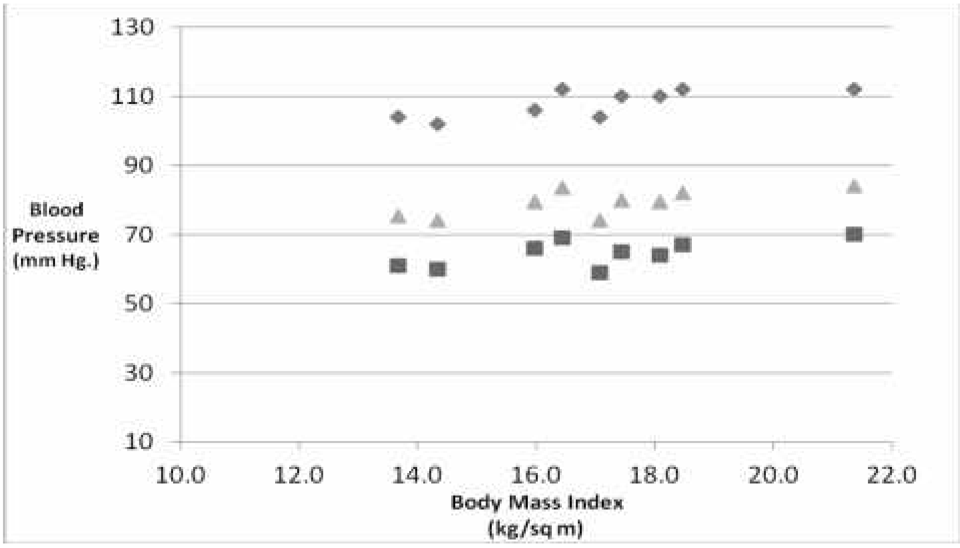

Fig. 4. Relationship of blood pressure and body mass index in girls.

In Figs 3 and 4, no specific age trend of BMI is seen, as a whole BP increases with the rise of BMI. In the late childhood and adolescence period, the hormonal spurt plays a key role in controlling BP. Emotions, anger, stress act as the key indicators of determining the BP in age group 8 - 16 years. In the present study, statistically significant positive correlation was found between all the anthropometric measures and SBP and DBP. Studies in various populations also showed strong relationship between different anthropometric indicators and BP levels (Gupta and Kapoor 2010), (Doll *et al.* 2002), Shanthirani *et al.* 2005). The significant association of BMI with SBP and DBP is also evident from Pearson's correlation coefficient (*r*) value among boys and girls in the present study (Table 1). These findings are in agreement with other studies (Gupta and Kapoor 2010), (Shanthirani *et al.* 2005) which support a strong relationship between BMI and BP across developed and developing countries (Gardner and Poehlman 1995), (Kusuma *et al.* 2002). Several studies have been done in different parts of India on factors affecting cardiovascular functions (SrikanthJ *et al.* 2011). Obesity or excess relative weight tends to be associated with increased risk of disease morbidity and mortality (Tyagi *et al.* 2007). BMI is widely accepted as one of the best indicator of nutritional status in adults (Shetty and James 1994, Kapoor *et al.* 2010). The importance of BMI has been recognized for estimating cardiovascular disease (CVD) risk factors, particularly due to their positive association with hypertension (Dua and Kapoor 2000). Linear correlations between both SBP and DBP for all anthropometric measurements were found to be significant in the adult Brazilian men and BP increased with higher BMI and WC (Cassani *et al.* 2009). Many investigators have earlier reported significant positive correlation of BMI with SBP and DBP (Poulter *et al.* 1990), (Ferguson *et al.* 2008) and (Wang *et al.* 2010). Previous studies stated that the overall prevalence of relatively high BP of children and adolescents aged 7 - 17 increased from 19.29% (boys) and 14.69% (girls) in 2000 to 26.16% (boys) and 19.77% (girls) in 2010, respectively (Zhang *et al.* 2012).

CONCLUSION

Prevalence of high BP was found greater in those with high BMI. WC was found to be more correlated with BP than BMI. WB school boys in the rural environment showed less prevalence of obesity but more elevated BP than girls. Among boys and girls, overweight or obesity has been found to be risk factor, more for DBP, being more dependent on peripheral resistance. Moreover, DBP is closely correlated with SBP, hence the factors that increase DBP may increase SBP. In the past 10 years, the prevalence of relatively high BP increased. Hypertension and related diseases were characterized as a “disease of civilization” resulting from an incompatible interaction between a modern affluent life style and paleolithic gene (Dua *et al.* 2014).

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