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Blood Pressure and Waist Circumference: An Empirical Study of the Effects of Waist Circumference on Blood Pressure among Bengalee Male Jute Mill Workers of Belur, West Bengal, India

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Abstract An investigation of 150 adult Bengalee Hindu male jute mill workers in Belur, a suburb of Kolkata, West Bengal, India, was conducted to study the relationship between central obesity and blood pressure. In accordance with their waist circumference measurement, the subjects were divided into two categories: centrally non-obese (CNO) and centrally obese (CO). The participants were classified as the CO group if they had a WC of 80 cm or more. Results showed that none of the CNO subjects was mild hypertensive (SBP≧140 mmHg and/or DBP≧90 mmHg) while 85 of the CO subjects (82.5%) were mild hypertensives, the difference being statistically significant (chi-square=9.33; $p<0.0025$). Moreover, the data also revealed that the CO subjects had much ($p<0.001$) greater mean weight, body mass index (BMI), systolic (SBP), diastolic (DBP) and mean arterial (MAP) blood pressure than the CNO group members. The significant difference in blood pressure was found even after correcting the confounding effects of age and BMI variables. The results of this study showed that, the Bengalee male jute mill workers in the CO group had significantly higher blood pressure irrespective of age and overall adiposity (BMI). Therefore, the presence of central obesity is deemed a risk factor, for hypertension regardless of age and BMI. Thus, a WC cut-off point of 80 cm could be employed for health promotion among Bengalee men so as to prevent and manage hypertension effectively. *J Physiol Anthropol Appl Human Sci 22 (4): 169–173, 2003* http://www.jstage.jst.go.jp/en/

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Introduction

Over the last three decades it has become clear that excessive accumulation of body fat within the abdominal region is the main determinant of obesity related diseases such as coronary-heart disease (CHD), type II diabetes and hypertension (HT). Generally, there are some methods to measure directly the intra-abdominal fat volume such as computed tomography (CT) and magnetic resonance imaging (MRI). However, these methods are very costly and time consuming, hence they are not practical for epidemiological investigations. Therefore, most population based cross-sectional and prospective studies on the correlations between fat distribution and health problems have relied on anthropometric measurements (Seidell and Bouchard, 1997).

Anthropometric measurements, such as body mass index (BMI) and waist circumference (WC) have been the subject of much epidemiological and pathophysiological research involving overweight, obesity, body fat distribution and health outcomes (Seidell et al., 2001). The BMI, which is routinely employed as an indicator of fatness, may not be adequate in describing the relationship between adiposity and diseases (Fujimoto et al., 1995). On the other hand, WC reflects abdominal fat distribution and is not greatly influenced by height (Lean et al., 1998). Moreover, WC correlates strongly with measures of risk for CHD such as hypertension or blood lipid levels (Kopelman, 2000). WC gives the best assessment of intra-abdominal fat as opposed to subcutaneous fat (Bjorntorp, 1987) and is also an indicator of changes in intra-abdominal fat during weight loss (Van Dev Kooy et al., 1993). Moreover, WC provides a simple yet effective measure of truncal adiposity (Taylor et al., 2000). Obese individuals with excess fat in the abdominal depots are at risk of negative health consequences, with certain populations such as Indians (both migrants as well as sedentes), carrying higher levels of risk than others (McKeigue et al., 1991; Enas et al., 1992; Bose, 1997). The association between abdominal obesity and related medical problems such as hypertension and others, may severely reduce productivity at work, for instance, through absenteeism and disability (Seidell et al., 2001). Such associations are particularly important to those such as Indians (both native and immigrants) who are genetically susceptible to abdominal or central obesity.

There are many studies worldwide (Gerber et al., 1995) on the association between BMI and body fat distribution with blood pressure (Gerber et al., 1995). Several recent publications from India (Shelgikar et al., 1991; Ramachandran et al., 1992; Gupta and Majumdar, 1994; Gupta and Mehrishi, 1997; Singh et al., 1998a, 1998b; Ghosh et al., 2000; Bose and Das Chaudhuri, 2001; Bhadra et al., 2002) have reported the significant association of abdominal or central adiposity with established risk factors for CHD in various ethnic groups. A more recent study by Dasgupta and Hazra (1999) had recommended that a WC cut-off point of 80 cm could be used to define centrally obese individuals among Bengalee men. However, this study did not include blood pressure as a variable. A literature review revealed that, previous studies from the Indian subcontinent have not deployed a specific cut-off point of WC to define central obesity. In view of this, the present work was undertaken to compare the blood pressure profiles between centrally non-obese (CNO) and centrally obese (CO) adult Bengalee Hindu male jute mill workers in Belur, a suburb of Kolkata, West Bengal, India.

Material and Methods

Study population

The present study was conducted from April 2000 to July 2000 at Ambica Multifibres Limited, a jute mill located at Belur, 20 km from Kolkata. A total of 150 Bengalee male Hindu jute mill workers aged 18 years and over were selected randomly. Information on age and ethnicity was collected using a questionnaire. The subjects were requested to make an appointment at the medical clinic of the mill. A written consent was obtained from each participant before the commencement of the study.

Anthropometric measurements

All anthropometric measurements were made following the standard techniques (Lohman et al., 1988). Height was measured to the nearest 0.1 cm using Martin's anthropometer. Body weight of lightly-clothed subjects was recorded to the nearest 0.5 kg on a weighing scale (Doctor Beliram and Sons, New Delhi, India). For height and weight, individuals were requested to remove their shoes before taking measurements. WC measurements were made to the nearest 0.1 cm using a tape measure (Triced, Shanghai, China). Body mass index (BMI) was calculated using the standard equation as follows:

$$\text{BMI (kg/m}^2) = \text{Weight (kg)/Height (m)}^2.$$

Based on the classification of Dasgupta and Hazra (1999), individuals were classified as centrally non-obese (CNO) and centrally obese (CO). The following cut-off points were used:

$$\text{CNO} < 80.0\text{ cm.}$$

$$\text{CO} \geqq 80.0\text{ cm.}$$

The samples of CNO and CO groups consisted of 47 and 103 individuals, respectively.

Blood pressure measurements

Blood pressure measurements were made after the completion of anthropometric measurements. Left arm blood pressure was taken with a sphygmomanometer and stethoscope after the participant had been seated in a relaxed position for five minutes. Prior to taking measurements, subjects were instructed to lie on the bed and then the left arm was placed at the side of the body. Two forenoon measurements were recorded and averaged for analyses. A five minutes relaxation period between the two measurements was maintained for all subjects. Systolic (SBP) and diastolic (DBP) blood pressures were recorded to the nearest mmHg as the appearance (phase I) and disappearance (phase V) of Korotkoff sounds, respectively. Mean arterial pressure (MAP) was computed using the standard formula:

$$\text{MAP(mmHg)} = \text{DBP} + 1/3(\text{SBP} - \text{DBP}).$$

Individuals were classified as hypertensives ($SBP \geqq 160$ mmHg and/or $DBP \geqq 95$ mmHg) or normotensives ($SBP < 160$ mmHg and $DBP < 95$ mmHg) following the WHO (1996) guidelines. Subjects were further categorized as non mild hypertensives ($SPB \geqq 140$ mmHg and/or $DBP \geqq 90$ mmHg) and mild hypertensives ($SBP < 140$ mmHg and $DBP < 90$ mmHg).

Statistical analyses

All variables were checked for normality and it was found that none of the distribution was significantly skewed. Statistical analyses were performed using SPSS-PC (Statistical Package for Social Sciences, Version 5) Package.

Results

The majority of the subjects were normotensive ($n = 145$, 96.7%). The mean ages of the CNO and the CO subjects were 30.3 (s.d. = 11.8 years) and 45.4 (s.d. = 14.2) years, respectively. The baseline anthropometric and blood pressure characteristics of the two groups are presented in Table 1. The CO subjects had significantly ($p < 0.001$) higher mean weight, BMI, SBP, DBP and MAP compared with the CNO individuals. The percentile distributions (figures are not shown) of these variables were consistently higher among the CO group members than those among the CNO. None of the CNO subjects was mild hypertensive while 85 of the CO subjects (82.5%) were. Regarding the frequency of mild hypertensives, the difference between the CNO and the CO subjects was statistically significant (chi-square=9.33; $p<0.0025$).

Since there were significant differences in mean age and BMI between the two groups, analyses of variance were undertaken to test the impact of central obesity status (CNO=no, CO=yes) on SBP, DBP and MAP, after controlling for age and BMI. Results (Table 2) revealed that the central obesity status had significant positive effects on SBP ($F=17.625$, $p<0.001$), DBP ($F=12.251$, $p<0.005$) and MAP ($F=16.308$, $p<0.001$) even after correction of the two covariates (age and BMI). There were significant differences (results not shown) in mean SBP (grand mean=124.7 mmHg, CNO=−4.44, CO=+2.03), DBP (grand mean=81.5 mmHg, CNO=−2.76, CO=+1.26) and MAP (grand mean=95.9 mmHg, CNO=−3.32, CO=+1.52) even after controlling age and BMI.

Table 1 Anthropometric and blood pressure characteristics of centrally non-obese (CNO) and centrally obese (CO) Bengalee male jute mill workers of Belur, West Bengal, India

Variable	CNO (n=47)	CO (n=103)	t
Height (cm)	161.5 (7.5)	162.3 (8.2)	0.55
Weight (kg)	53.5 (7.0)	64.3 (8.9)	7.37*
BMI (kg/m^2)	20.5 (2.0)	24.4 (2.8)	9.77*
SBP (mmHg)	119.3 (4.8)	127.2 (7.7)	7.63*
DBP (mmHg)	78.2 (3.3)	83.1 (5.9)	6.41*
MAP (mmHg)	91.9 (3.5)	97.7 (6.2)	7.42*

Standard deviations are presented in parentheses.
* $p<0.001$.
BMI=body mass index, SBP=systolic blood pressure, DBP=diastolic blood pressure, MAP=mean arterial pressure.

Discussion

Recent investigations in Brazil (Velasquez-Melaendez et al., 2002), Taiwan (Huang et al., 2002) and Finland (Lakka et al., 2002) were conducted to study the relationship between WC and blood pressure. However, there is no research in India comparing the blood pressure profile between the CNO and the CO individuals using WC as a marker for abdominal obesity. The present study was undertaken to compare blood pressure profile between the CNO and the CO adult Bengalee Hindu male jute mill workers using a WC cut-off point of 80 cm. We also tested the impact of the presence of central obesity (used as a discrete variable: no/yes) on blood pressure after correcting age and BMI.

This study demonstrated that the age factor had a significant effect on blood pressure. However, while BMI did not have any significant effect, the CO status had a significant impact on the blood pressure. Moreover, the CO subjects had much greater mean SBP, DBP and MAP than the CNO individuals. This significant difference still existed even after correcting the confounding effects of age and BMI variables. It implied that the Bengalee male jute mill workers with excess abdominal adiposity had significantly higher blood pressure irrespective of age and overall adiposity (BMI). Similar findings were found in several recent studies regarding the effects of WC on blood pressure (Gerber et al., 1995; Seidell et al., 1990; Bhadra et al., 2002; Lakka et al., 2002).

The present study demonstrated that among Bengalee men, the presence of central obesity is a risk factor, for hypertension independent of age and BMI. It has been suggested that WC relates closely to abdominal fatness and changes in WC reflect changes in cardiovascular risk factors (Wing et al., 1995; Pouliot et al., 1994). Although age is strongly associated with BMI, WC and blood pressure, it is a non-modifiable factor. However, both BMI and WC are modifiable but as shown in this study, WC is much more strongly associated with blood pressure. Therefore attention should be given to maintaining a low and stable WC. Moreover, WC is easy and cheap to measure and is therefore an attractive measurement to be included in routine epidemiological investigations (Seidell et

Table 2 Analyses of variance of blood pressure and central obesity status (no=1, yes=2) with age and BMI as covariates

Dependent variable	Covariates	Main effect	Sum of squares	F
SBP	Age		1240.531	27.845**
	BMI		100.810	2.263
		Central obesity	785.235	17.625**
DBP	Age		823.698	33.207**
	BMI		0.120	0.005
		Central obesity	303.876	12.251*
MAP	Age		953.193	35.377**
	BMI		12.799	0.457
		Central obesity	439.407	16.308**

* $p<0.005$, ** $p<0.001$.

al., 1990). The strategy for modifying the lifestyle to prevent an increase in WC is of paramount importance.

Conclusion

The present study indicated that at any given age and BMI, preventing an increase in WC may have definite health benefits among the adult Bengalee men. This benefit becomes more obvious with advancing age. Moreover, a WC cut-off point of 80 cm could be utilized among this population (for men only) for health promotion purposes to prevent and manage hypertension. Further research is needed to determine an effective cut-off point of WC for the Bengalee women.

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