Comparative evaluation of obesity measures: relationship with blood pressures and hypertension

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ABSTRACT

Introduction: The purpose of the present study was to compare the relationship of all obesity measures with blood pressures and to find out the best obesity measure, associated with greater risk of hypertension.

Methods: A total of 180 adult Bengalee Hindu men from Hridoypur of 24 Pgs (N), West Bengal, India were evaluated in the present cross-sectional study. Biosocial data (such as age, education, occupation), anthropometry and blood pressure measurements were obtained. Body mass index (BMI), waist hip ratio (WHR), conicity index (CI) and waist stature ratio (WSR) were subsequently derived. Statistical analysis includes linear and logistic regression.

Results: The mean age of the studied individuals was 35.7 years (standard deviation, 9.35 years) and the frequency of hypertensive individuals was 11.7 percent. WSR explained 14.3 percent variance of systolic blood pressure (SBP), followed by waist circumference (WC) (13.0 percent) and BMI (13.1 percent). BMI (8.8 percent), WC (8.6 percent) and WSR (8.4 percent) explained closely the same amount of variance of diastolic blood pressure (DBP). All obesity measures were significantly and positively correlated with blood pressures. The odds-ratio (OR) associated with a 1 kilogramme per square metre increase in BMI was 1.17. Comparing values for a 0.1 increase in WSR was 1.22, followed by WHR (OR 1.09). A 1.0 cm increase in WC was associated with OR 1.07 followed by OR 1.06 for a 1.0 increase in CI. In multivariate analysis, significant predictors of hypertension were age and BMI.

Conclusion: Among all obesity measures, WSR and BMI explained comparatively larger amount of variance of SBP and DBP, respectively. However, the greater risk of developing hypertension was associated with increasing BMI.

Keywords: hypertension, obesity, waist stature ratio

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INTRODUCTION

A number of anthropometric measures were used as proxy measures of obesity for the evaluation of fat tissue accumulation. Obesity measures, i.e. waist circumference (WC), body mass index (BMI), waist hip ratio (WHR), conicity index (CI) and waist stature ratio (WSR) were most commonly used as risk factors of non-communicable diseases like cardiovascular disease, type 2 diabetes mellitus and hypertension.[1-3] However, the question regarding the best obesity measures associated with blood pressures and hypertension remain unsolved. One possible reason might be the lack of independent comparative studies considering all these measures of obesity in search of the best obesity measures associated with blood pressure and hypertension. However, it might be difficult to determine a universally-applicable best obesity measure associated with blood pressures and hypertension, due to the existence of biological and cultural variation among different ethnic groups. However, possibilities seem to be remained open in specific ethnic groups. In view of the above consideration, to the best of our knowledge, the present study is the maiden attempt considering all the obesity measures in the form of comparative evaluation, to study the relationship of obesity measures with blood pressures, and to find out the best obesity measure associated with greater risk of hypertension among the adult Bengalee Hindu men.

METHODS

The sample of the present cross-sectional study comprised 180 adult Bengalee Hindu men aged 20–61 years from Hridoypur of 24 Pgs (N), West Bengal, India. Individuals were informed by letters and oral communication regarding the aims and objectives of the present study.

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The interested individuals were incorporated and those who were under medication were excluded from the present study. All participants were asked to complete a questionnaire that included specific information on age, occupation, education, tobacco and alcohol intake. Height (to the nearest 0.1 cm), weight (to the nearest 0.5 kg), waist circumference (to the nearest 0.1 cm) and hip circumference (to the nearest 0.1 cm) were measured according to standard procedures.[4] BMI, WHR, CI and WSR were then computed. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurements were taken following standard procedure.[5] Hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg) was defined according to the Seventh Report of the Joint National Committee (JNC-7) recommendation.[6]

Descriptive statistics for anthropometric and physiological variables were computed by mean and standard deviation (SD). Regression analysis was used to understand the relationship between obesity measures and blood pressures after controlling significant biosocial variables (age, occupation, education, tobacco and alcohol intake). The association between obesity measures and hypertension were analysed by logistic regression. Statistical analysis was performed using the Statistical Package for Social Sciences version 9.0.0 (SPSS Inc, Chicago, IL, USA). A p-value of < 0.05 was considered as significant.

RESULTS

The mean age of the studied individuals was 35.7 years (SD 9.35 years), with a range of 20–61 years. The majority of subjects (64.1%) had never consumed alcohol, and rest of the subjects was occasional consumers. Furthermore, 68% individuals were current smokers, while the rest had never smoked. With regard to the occupation, the majority (38.8%) was engaged in business and the rest was occupied by various kinds of service. However, 60% of individuals were literate. The mean and SD of anthropometric and blood pressure variables of the studied population are shown in Table I. The total number of hypertensive individuals was 21 (11.7%). Regression analysis of obesity measures in explaining SBP and DBP are presented in Table II.

The results (Table II and Fig. 1) demonstrated that WSR was positively correlated ($\beta = 0.378$) and explained 14.3% variance of SBP, while both WC (13.0%) and BMI (13.1%) explained closely to the same amount of variance followed by WHR (8.2%) and CI (7.1%). On the other hand, BMI (8.8%), WC (8.6%) and WSR (8.3%) explained nearly the same amount of variance of DBP followed by WHR (5.3%) and CI (3.4%). All obesity measures were significantly ($p < 0.01$) and positively correlated with blood pressures. The order of correlation with SBP was WSR > BMI > WC > WHR > CI and with DBP was BMI > WC > WSR > WHR > CI. Table III shows the odds-ratio (OR) of developing hypertension with increasing obesity measures. The OR associated with a 1 kg/m² increase in BMI was 1.17. Comparing values for a 0.1 increase in WSR was 1.22. A similar increase in WHR was associated with an OR of 1.09. A 1.0 cm increase in WC was associated with OR 1.07 followed by

Table I. Baseline characteristics of the study population.

Variables	Mean	SD
Height (cm)	163.96	6.36
Weight (kg)	60.53	11.54
Waist circumference (cm)	80.67	10.00
Hip circumference (cm)	89.55	6.76
Body mass index (kg/m²)	22.44	3.66
Waist hip ratio	0.90	0.07
Conicity index	1.22	0.07
Waist stature ratio	0.49	0.06
Systolic blood pressure (mm/Hg)	118.77	11.85
Diastolic blood pressure (mm/Hg)	78.10	8.74

Table II. Regression analysis of obesity measures with blood pressures.

Dependent variables	Predictors	ß	R^2	Significance
SBP				
	WC	0.360	0.130	0.001
	BMI	0.362	0.131	0.001
	WHR	0.287	0.082	0.001
	CI	0.267	0.071	0.001
	WSR	0.378	0.143	0.001
DBP				
	WC	0.293	0.086	0.001
	BMI	0.297	0.088	0.001
	WHR	0.229	0.053	0.002
	CI	0.185	0.034	0.013
	WSR	0.289	0.083	0.001

Table III. Odds-ratios for developing hypertension with increasing obesity measures.

Variables	OR	95% CI	Significance
WC	1.07	1.0 –1.12	0.01
BMI	1.17	1.04–1.32	0.01
WHR	1.09	1.01–1.17	0.02
CI	1.06	1.00– 1.13	0.05
WSR	1.12	1.03–1.22	0.01

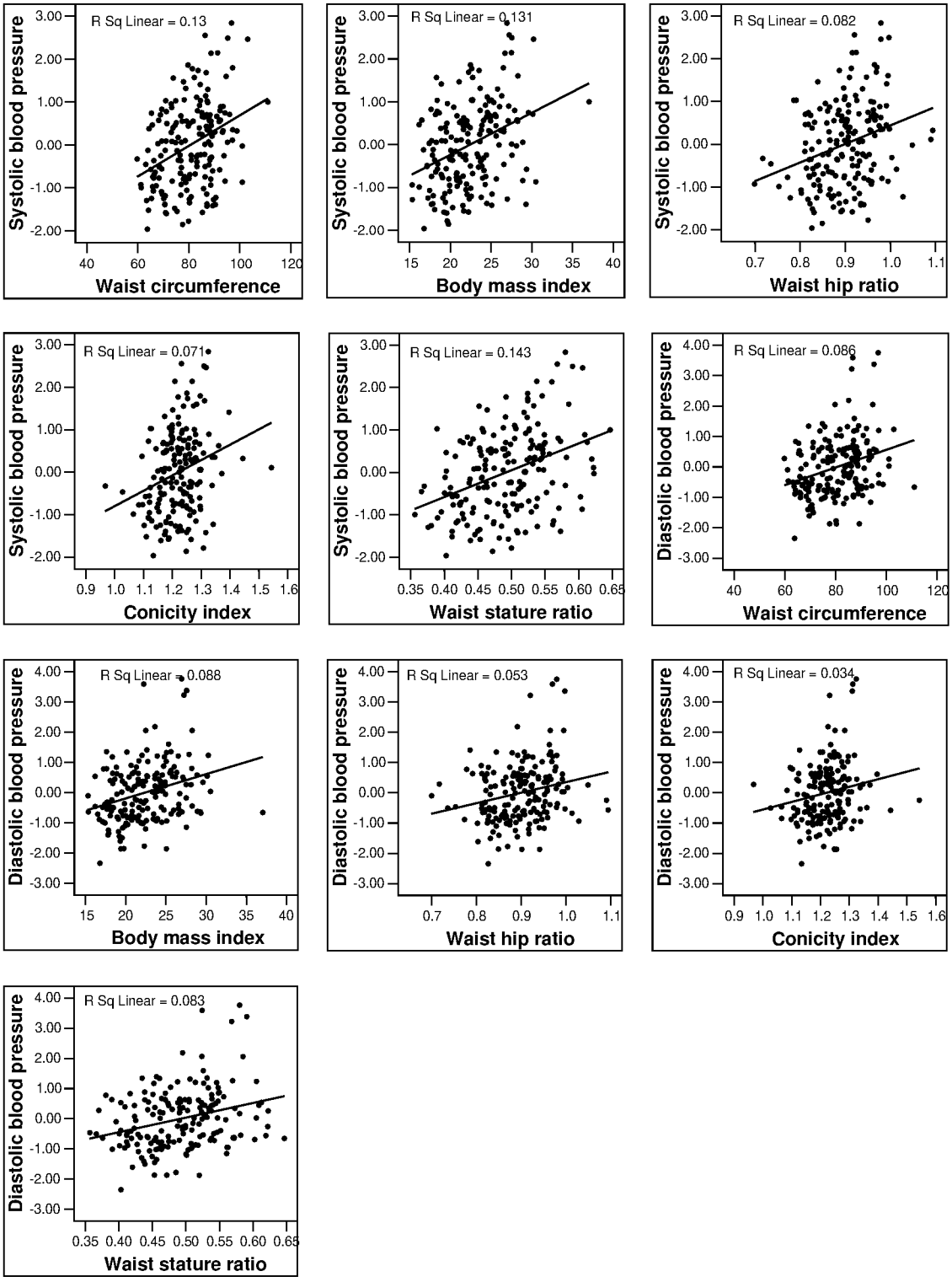

Fig. 1 Regression curves of different obesity measures in explaining adjusted systolic and diastolic blood pressures.

OR 1.06 for a 1.0 increase in CI. Multivariate analysis, including age and other obesity measures, indicated that the significant predictors of hypertension were age (OR 1.10; 95% CI, 1.04–1.17; $p < 0.01$) and BMI (OR 1.15; 95% CI, 1.00–1.31; $p < 0.04$).

DISCUSSION

Hypertension is now recognised globally as a major public health problem,[7] in terms of a well-known risk factor for coronary heart disease, type 2 diabetes mellitus and renal disease.[8–10] Due to the quickening pace of adoption of

changing lifestyles by people in developing countries, a sharp rise in morbidity and mortality from cardiovascular diseases, particularly those related to hypertension, have been noted.[11] Hypertension is directly responsible for 57% of stroke deaths and 24% of all coronary disease deaths in India. A rough estimate shows that there are 31.5 million hypertensive in rural and 34 million in urban Indian population.[9] The present study, being the first report from adult Bengalee Hindu men, demonstrates that the frequency of hypertensive males is 11.7%.

Epidemiological studies have found a progressive increase in the prevalence of elevated blood pressure with increasing adipose tissue.[12] In recent decade, many prospective and cross-sectional studies using anthropometric measures have been done in order to understand the relationship between elevated blood pressure and hypertension.[13,14] Different obesity measurements like BMI, WC, WHR, WSR were investigated for this purpose. However, the question regarding the best obesity measures associated with blood pressures and hypertension remain unsolved. The only way to find out the best measures is by comparative study considering all obesity measures, and only one study[15] in Cambridge, UK had considered all the obesity measures in order to understand the relationship between obesity measures and blood pressures. In view of the above consideration, the present study was undertaken to compare the relationship of all obesity measures with blood pressures and to find out the best obesity measure, associated with a greater risk of hypertension.

Among all obesity measures, BMI, WSR, and WC showed stronger correlations with both SBP and DBP; however, the correlation with SBP was stronger than DBP. The results also emphasised that WSR explained comparatively larger amount of variance of SBP. With regard to DBP, all three obesity measures (BMI, WC and WSR) explained an almost similar amount of variance. The findings of the order (with SBP, WSR > BMI > WC > WHR > CI and with DBP, BMI > WC > WSR > WHR > CI) of correlation between obesity measure and blood pressure in the present study are in agreement with the previous report from Cambridge.[15]

The results of the present study also revealed that the OR of developing hypertension was comparatively greater with increasing BMI than other obesity measures (WC, WHR, CI and WSR). Since none of the studies from India and abroad utilised all obesity measures to find out the risk of developing hypertension with increasing obesity measures, comparison with the present study cannot be made. However, in another recent study, Han et al demonstrated that the risk of developing hypertension was greater with increased BMI compared to WC and WHR.[16] Multivariate analysis considering age and all obesity measures demonstrated that age and BMI were the significant predictors of hypertension. However, as age is a non-modifiable factor, BMI, as a modifiable factor, could be used for health promotion among the adult Bengalee men to prevent and manage hypertension effectively. Since the present study is cross-sectional and restricted to males, further investigations considering all obesity measures on the females as well as in other ethnic groups are necessary for effective prevention and management of hypertension.

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