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A Comparative Study of Adiposity and Central Body Fat Distribution of Normotensive and Hypertensive Older Bengalee Hindu Women of Calcutta, India

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A B S T R A C T

A comparative investigation of 134 normotensive and 145 hypertensive Bengalee Hindu older women (aged 50 years and above) of Kalighat, South Calcutta, India, was undertaken to study differences in levels of adiposity and central body fat distribution between the two groups. Results revealed that hypertensive (HT) subjects had significantly ($p < 0.05$) greater (age controlled) mean values of weight, body mass index (BMI), minimum waist circumference (MWC) and waist-hip ratio (WHR) compared with normotensive (NT) subjects. Percentile distributions for all these variables and index showed consistently higher values among the HT patients as compared with NT subjects. The frequency of central obesity (WHR > 0.85) was significantly higher ($^2 = 5.16178$, $p < 0.025$) among HT (62.8%) patients compared with NT (49.3%) subjects. Multiple regression analyses revealed that BMI and WHR had significant effect (age controlled) on SBP (BMI: $p < 0.01$; WHR: $p < 0.005$) and DBP (BMI: $p < 0.05$; WHR: $p < 0.005$). The significant impact ($p < 0.05$) of WHR on SBP and DBP remained even after controlling for BMI. Thus, these results indicated that hypertensive individuals have significantly enhanced levels of central body fat distribution (WHR), irrespective of their age and level of generalized adiposity (BMI), compared with normotensive subjects.

Introduction

Essential hypertension is a common condition and is a major risk factor for several potentially fatal diseases. Prevention of hypertension (HT) or even a reduction of blood pressure among hypertensives has been shown to reduce morbidity and mortality in populations[1]. Among the several risk factors for HT, the

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commonest is obesity. Truncal obesity measured by waist-hip ratio (WHR) has emerged as an important factor in the etiology of coronary heart disease (CHD), non-insulin dependent diabetes mellitus (NIDDM) and HT[2]. Persons with increased WHR have higher prevalence of premature atherosclerosis, hyperinsulinaemia, insulin resistance, NIDDM and HT. This syndrome of insulin resistance was originally described by Reaven[3] as Syndrome X.

Once believed to be a problem of industrialized populations, HT is now becoming a major public health concern of even developing countries like India[4–5]. India is undergoing a rapid transition, with an alarming rise in the prevalence of cardiovascular diseases[6]. In a recent publication[6] it has been reported, based on available data, that there are nearly 20 million hypertensives in India. Studies[7–8] have also indicated that hypertension is a major health problem among the elderly in India.

According to the 1991 Census, the total aged population of India is approximately 109 million, or 12.9% of the total population. This percentage will increase up to 14% by the year 2020[9]. Considering the magnitude of this population, the number of cases in the community and the potential loss due to morbidity and mortality associated with hypertension, the impact of control measures would be far greater than has been estimated hitherto[6]. The prevalence of chronic diseases like CHD, NIDDM and HT are high among the elderly population of India[7,10].

Several publications have reported the association of measures of body fat and fat distribution with blood pressure. An extensive review of these studies can be found in Gerber et al.[11]. Studies[11–15] have found that centrally located body fat is more closely associated with high blood pressure compared with lower body fat. Baumgartner et al.[16] also reported significant association between systolic blood pressure (SBP) and fatness in males and females, but the pattern of fat distribution was associated only with diastolic blood pressure (DBP) in women.

Recent studies from India[5,17–22] have investigated the relationship of adiposity with blood pressure. However hitherto, no investigation has systematically compared the levels of adiposity and central body fat distribution among normotensive (NT) and hypertensive (HT) Bengalee women.

The present investigation examined the differences in adiposity and central body fat distribution (WHR) between normotensive (NT) and hypertensive (HT) older Bengalee Hindu women of Kalighat, South Calcutta, India.

Material and Methods

The study population of the present investigation consisted of 279 women aged 50 years and above. They belonged to the Bengalee Hindu caste population residing in 88 ward at Kalighat, South Calcutta. Name and address of the subjects were collected from local voter list of 1998 and age was ascertained from voter's registration record. Subjects were also requested to complete a three-page questionnaire, which included specific questions on age and ethnicity. A total of 286 individuals were studied but seven women were excluded because of missing data.

All anthropometric measurements were made by trained investigators using standard anthropometric techniques[23]. Height and sitting height were measured to the nearest 0.1 cm using Martin's anthropometer. Body weight of lightly clothed subjects was recorded to nearest 0.5 kg on a weighing scale. Both for height as well as weight, participants were requested to remove their shoes prior to taking measurements. Circumference measure-

ments were made to the nearest 0.1 cm. using a tape measure. Skinfolds were measured on the left side using a Harpenden skinfold caliper. Body mass index (BMI) was computed using the standard equation (BMI = Weight in kg / (stature in meters)^2). Waist-hip ratio (WHR) was computed using the standard equation: WHR = Waist circumference in cm / hip circumference in cm.

Technical error of measurements (TEM) was calculated and the results were found to be within reference values cited by Ulijaszek and Lourie[24]. Therefore, TEM was not incorporated in statistical analyses.

Individuals were categorized as normal or centrally obese based on WHR values according to the classification of the Fifth Report of the Joint National Committee on Detection, Evaluation and Treatment of High Blood Pressure[25]. The cut-off points used were:

Normal: WHR 0.85
Centrally obese: WHR > 0.85.

Left arm blood pressure was taken with a sphygmomanometer and stethoscope after the subject had been seated for five minutes. Systolic (SBP) and diastolic blood pressure (DBP) were recorded as the appearance (Phase I) and disappearance (Phase V) of sounds, respectively. Prior to the measurements, subjects were instructed to lie in bed and the left arm was placed at the level of the heart. Two measurements were taken (in mmHg) and mean values used for all analyses. A five-minute interval between the two measurements was maintained for all the subjects. All subjects were categorized into two categories, namely normotensive (NT) and hypertensive (HT) following the World Health Organization (WHO) criteria[26]. Individuals were classified as hypertensive (HT) if they had SBP 160 mmHg and/or DBP 95 mmHg. The remaining subjects were classified as normotensive (NT).

All statistical analyses were performed using the SPSS Package (SPSS/PC+ Version 5). Statistical significance was set to a value of $p < 0.05$.

Results

The mean ages of NT (X = 58.8, SD = 7.4 years) and HT (X = 62.4, SD = 9.1 years) subjects were similar. Table 1 presents the mean and standard deviation of the anthropometric characteristics and blood pressure of the NT and HT subjects. Age controlled differences in mean values of anthropometric variables and indices between the two categories were examined and the results are presented in Table 1. Results revealed that HT subjects had (age controlled) significantly higher ($p < 0.05$) mean weight, BMI, MWC and WHR, compared with NT individuals. No significant difference existed between HT and NT in the other anthropometric characteristics.

To further investigate whether there was any difference in the distribution of weight, MWC, BMI and WHR, between NT and HT individuals, percentile distributions were obtained and plotted (results not shown). It was observed that weight, MWC, BMI and WHR, showed consistently higher values among the HT patients as compared with NT subjects. These results provided further evidence that HT patients have significantly greater central fat distribution (WHR).

It was observed (Table 2) that the frequency of central obesity (WHR > 0.85) was significantly higher ($^2_1 = 5.16178$, $p < 0.025$) among HT (62.8%) patients compared with NT (49.3%) subjects.

Multiple regression analyses were undertaken to study the effect (age controlled) of BMI and WHR on SBP and DBP. Results (Table 3) revealed that both

TABLE 1
ANTHROPOMETRIC CHARACTERISTICS OF NORMOTENSIVE AND HYPERTENSIVE BENGALEE HINDU WOMEN

Variable	Normotensive X(SD)	Hypertensive X(SD)
Height (cm)	147.3 (5.4)	147.7 (6.7)
Sitting height (cm)	75.0 (3.7)	75.8 (4.7)
Weight (kg)*	47.0 (9.1)	49.5 (11.3)
Body mass index (kg/m^2)*	31.8 (5.8)	33.4 (7.0)
Circumferences (cm)		
Abdomen	79.3 (10.4)	81.5 (11.8)
Minimum waist*	73.3 (9.4)	76.0 (11.1)
Maximum hip	85.6 (8.2)	86.4 (10.4)
Chest	79.4 (7.5)	80.9 (8.3)
Mid-upper arm	23.8 (2.8)	24.5 (3.1)
Skinfolds (mm)		
Biceps	17.5 (5.5)	16.9 (5.6)
Triceps	19.7 (4.9)	19.5 (5.4)
Forearm	4.6 (1.3)	4.8 (1.6)
Anterior thigh	24.9 (7.3)	24.2 (6.5)
Medial calf	19.7 (4.9)	20.2 (5.7)
Abdomen	29.0 (8.1)	28.8 (8.1)
Subscapular	21.9 (5.9)	22.8 (6.8)
Suprailiac	23.3 (7.1)	23.7 (7.5)
Midaxillary	20.2 (5.6)	20.8 (6.3)
Chest	17.0 (4.4)	17.5 (5.0)
Central fat distribution index		
Waist-Hip ratio*	0.857 (0.084)	0.880 (0.082)

* Significant difference (age controlled) between NT and HT individuals ($p < 0.05$)

TABLE 2
DISTRIBUTION OF NORMAL AND CENTRALLY OBESE INDIVIDUALS AMONG NORMOTENSIVE AND HYPERTENSIVE SUBJECTS

	Normal N(%)	Centrally obese N(%)
Normotensive (n = 134)	68 (50.7)	66 (49.3)
Hypertensive (n = 145)	54 (37.2)	91 (62.8)

^{2} (1) = 5.16178; $p < 0.025$

BMI as well as WHR had significant effect on SBP (BMI: $t = 2.668$, $p < 0.01$; WHR: $t = 3.215$, $p < 0.005$) and DBP (BMI: $t = 2.368$, $p < 0.05$; WHR: $t = 3.074$, $p < 0.005$). Further multiple regression analyses including BMI as an independent variable revealed that (Table 4) WHR had significant impact on both SBP ($t = 2.471$, $p < 0.05$) as well as DBP ($t = p < 0.05$). These results implied that HT subjects have significantly greater central body fat distribution (WHR) compared with NT individuals, irrespective of their age and generalized adiposity (BMI).

TABLE 3
MULTIPLE REGRESSION ANALYSES (AGE CONTROLLED) OF BMI AND WHR WITH SBP AND DBP

	B	seB	Beta	T	Adj. R^2
Depend. var. = SBP					
BMI	0.467	0.175	0.159	2.668**	0.087
WHR	41.762	12.991	0.183	3.215***	0.098
Depend. var. = DBP					
BMI	0.253	0.107	0.147	2.368*	0.016
WHR	24.374	7.928	0.182	3.074***	0.029

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.005$

TABLE 4
MULTIPLE REGRESSION ANALYSES (AGE AND BMI CONTROLLED) OF WHR WITH SBP AND DBP

	B	seB	Beta	T	Adj. R^2
Depend. var. = SBP					
WHR	33.924	13.726	0.149	2.471*	0.104
Depend. var. = DBP					
WHR	20.337	8.390	0.152	2.424*	0.033

* $p < 0.05$

Discussion

Excess body fat is associated with health risk and increased mortality and morbidity. It has been reported[27] that total body fat appears to be a less important indicator of health than the pattern of fat distribution. Differences in fatness and fat distribution tend to be associated with marked differences in blood pressures. Several recent investigations from India[5,17–22] have studied the relationship of adiposity with blood pressure. However, data on adiposity and hypertension among older Bengalee female population is lacking.

Results of the present study showed that HT subjects had (age controlled) significantly greater weight, overall adiposity (BMI), central adiposity (MWC) and central body fat distribution (WHR) compared with NT individuals. The distributions of all these variables and index were consistently higher among HT subjects as evidenced from percentiles. The frequency of central obesity (WHR > 0.85) was significantly greater among HT than NT individuals. Multiple regression analyses demonstrated that WHR had significant impact on SBP and DBP even after controlling for age and BMI.

Increased WHR is associated with peripheral hyperinsulinaemia due to altered insulin metabolism[3]. Reaven and Hoffman[28] have proposed that hyperinsulinaemia, which is present in centrally obese subjects, might be causally related to hypertension but the exact nature of this mechanism is not fully understood.

Results of the present study provided clear evidence that among older Bengalee women, HT subjects have enhanced levels of central fat distribution compared with NT individuals.

Results obtained from the present study offer scope for further research on different Indian populations, incorporating metabolic parameters associated with hyperinsulinaemia. More importantly, prospective investigations should be undertaken to understand the mechanism by which central fat distribution is associated not only with hypertension, but also Syndrome X. No such study has been conducted in India. Prospective studies are also necessary on Indian populations for the determination of »cut-off points« for various indices of central fat patterning as risk factors for hypertension and Syndrome X.

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USPOREDNA STUDIJA PRETILOSTI I SREDIŠNJE TJELESNE RASPODJELE MASTI U NORMOTENZIVNIH I HIPERTENZIVNIH BENGALSKIH HINDU ŽENA STARIJE DOBI IZ KALKUTE, INDIJA

S A Ž E T A K

Usporedna studija 134 normotenzivnih i 145 hipertenzivnih Bengalskih Hindu žena starije dobi (50 i više godina) iz Kalighata, južna Kalkuta, Indija provedena je kako bi se ispitale razlike u razini pretilosti i središnjoj tjelesnoj raspodjeli između ove dvije skupine. Rezultati su pokazali kako hipertenzivne (HT) osobe imaju (dobno kontrolirano) značajno ($p < 0.05$) veće srednje vrijednosti tjelesne mase, indeksa tjelesne mase (BMI), najmanjeg opsega struka (MWC) te omjera struk/bokovi (WHR) u usporedbi s normotenzivnim (NT) osobama. Percentilna raspodjela za sve ove varijable i indekse pokazala je konzistentno veće vrijednosti kod hipertenzivnih u usporedbi s normotenzivnim osobama. Frekvencija centralne pretilosti ($WHR > 0.85$) bila je značajno veća ($^2 = 5.16178$, $p < 0.025$) među hipertenzivnim (62.8%) osobama u usporedbi s normotenzivnim (49.3%). Analiza višestruke regresije pokazala je kako BMI i WHR imaju značajan učinak (uz kontrolu dobi) na vrijednosti sistoličkog (BMI: $p < 0.01$; WHR: $p < 0.005$) i dijastoličkog krvnog tlaka (BMI: $p < 0.05$; WHR: $p < 0.005$). Značajan učinak ($p < 0.05$) WHR-a na sistolički i dijastolički krvni tlak ostaje i nakon poravnavanja za vrijednosti BMI. Stoga, ovi rezultati pokazuju kako hipertenzivne osobe imaju značajno povećanu razinu središnje raspodjele masnog tkiva (WHR), neovisno o dobi kao i o ukupnoj pretilosti (BMI), u usporedbi s normotenzivnim osobama.