

Association of Body Mass Index, Body Fat and Hypertension among Postmenopausal Women

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ABSTRACT The association of systolic and diastolic blood pressure with body mass index, waist hip ratio, the sum of three trunk skinfolds, the sum of the six skinfolds, the ratio of the sum of the trunk to the sum of the extremity skinfolds and relative fat pattern index and the correlations between each of these were examined among 30 hypertensive and 30 normotensive post menopausal women of Udaipur city. Anthropometric measurements and indices like weight, height, WHR, abdominal obesity, body mass index were higher in hypertensive women. Adiposity measures had consistent relationship with blood pressure. The correlation coefficients of the adiposity measure and blood pressure are intercorrelated with a few exceptions in both groups.

Menopausal transition is characterized by ovarian failure and its consequent decrease in female sex steroid production. Earlier studies suggest that an increase and redistribution of body fat during menopause predispose women to cardiovascular disease and metabolic syndrome. Post menopausal women seem to have less lean body mass (LBM) compared with pre menopausal women. Accordingly, a changing ovarian hormonal status may accelerate the loss of muscle mass and result in decreased muscle performance and functional capacity (Sipila, 2003).

Women face various psychological as well as physiological changes in the menopausal stage. There is a tendency to put on weight after menopause which is a predisposing factor for several other chronic disease like C.V.D., hypertension, etc. Seventy percent women of age 45-54 years are over weight or obese. Before the age of 50, majority of women tend to increase their weight slowly, whereas after menopause there appears to be an accelerated increase in fat mass and a change in preferential fat storage to a central part of body that is abdominal location (Evans, 2002). Obesity is recognized as an independent risk factor for hypertension, lipid abnormalities and diabetes mellitus, which are known to be independent risk factors for C.V.D. (Zodpey et al., 1994; Greenberg and Ibrahim,

1995; Ganguly et al., 1997). Several prospective studies have shown that both overall and abdominal obesity are related to cardiovascular disease, weight gain increases the risk of developing hypertension independent of age and blood pressure (Lee, 1996). Cardiovascular disease is the leading cause of death in women who have past the age of menopause (Upkar et al., 2000). Chandha (2001) also reported that majority of women, less than 65 years of age die of cardiovascular disease.

The body mass index (BMI) refers to the overall fatness where as waist to hip ratio (WHR) and conicity index (CI) refers to abdominal adiposity. Kawada (2002) reported that BMI has an influence on blood pressure and lipid profile and is a good predictor of hypertension and hyperlipidemia. In recent years, the conicity index (CI) has been identified as the most important risk factor for cardiovascular disease than the WHR because CI has several advantages over the WHR (Valdez et al., 1993).

Sensitivity of waist circumference is an index of disease risk in post menopausal women (Pelt et al., 2001). The WHR showed significant positive association with systolic and diastolic blood pressures but not with lipid variables in one of the rural populations (Gupta and Majumder, 1994). The body fat distribution changes according to menopausal status, with central obesity more pronounced in post menopausal women (Garauet, 2002).

In the present study an attempt have been

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made to examine the association of BMI and other adiposity measures with blood pressure.

MATERIALS AND METHODS

Sixty women (30 hypertensive and 30 normotensive) in the age group of 45-55 years, who were not suffering from chronic diseases, with complete absence of cycle from last one year and not undergone surgical removal of uterus were purposively selected for the present study. Blood pressure of all the women was measured using automatic blood pressure monitor at the time of sample selection. The subjects were categorized based on their blood pressure values suggested by JNC-IV, 1997.

The anthropometric measurements such as height, weight, waist and abdominal circumference and six skinfold thickness (SFT) ie measurements at triceps, biceps, subscapular, supra-iliac, abdominal and calf were recorded. By using the above anthropometric measurements, seven adiposity measures were derived namely body mass index [BMI = weight (kg)/height (m²)], four measures of body fat distribution ie., waist to hip ratio (WHR = waist circumference/hip girth), conicity index [CI = abdominal girth (cm)/0.109 $\sqrt{W(kg)/Ht(m)}$], the sum of six skinfolds (SF₆ = abdominal + subscapular + suprailiac + calf + triceps + biceps). Two measures of fat patterning ie., the

ratio of the sum of the trunk to the sum of the extremity skinfolds [TE ratio: TSF₃/(calf+triceps+biceps)] and relative fat pattern [RFPI = subscapular/(subscapular+suprailiac)] was also calculated according to James et al., (1998). The waist to hip circumference ratio (NIN, 1998), TSF₃, SF₆, TE ratio and RFPI (Hasstedt et al., 1989) and the conicity index was calculated according to Valdez et al. (1993).

Statistical Analysis: Pearson's correlation coefficient was used to determine the association of body fat measurements, age and hypertension.

RESULTS

The distribution of subjects based on blood pressure is presented in figure 1. It was observed that majority of women (40%) were having high normal blood pressure (130-139/85-99 mmHg respectively) while 31 percent women had stage II hypertension (160-179/100-109 respectively).

Percentage distribution of the subjects according to their anthropometric measurements body fat distribution and body fat pattern presented in table 1 & 2. The means of all the variables were higher in hypertensive women than normotensive women. Hypertensive women had higher mean values of abdominal circumference, hip circumference and all skinfolds measurements.

The Pearson's correlation coefficients among

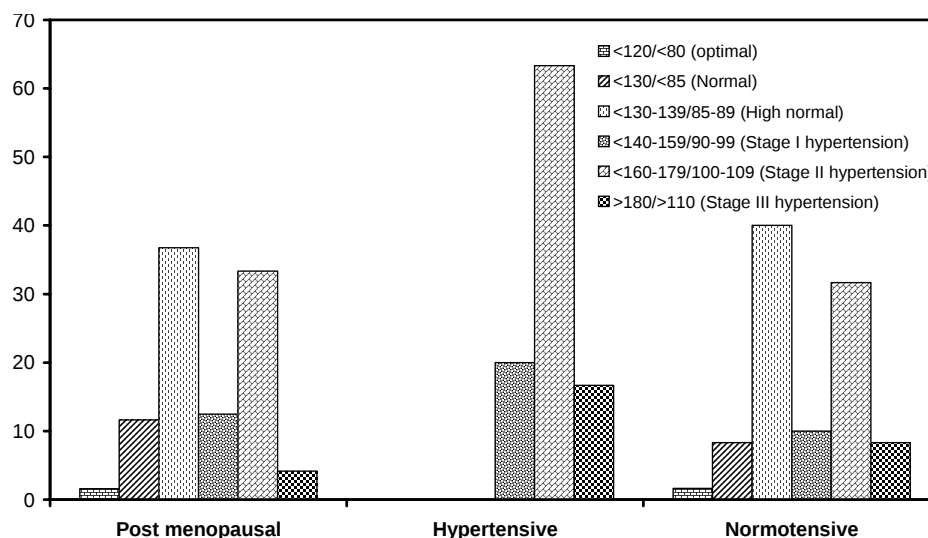


Fig. 1. Percentage distribution of subjects on the basis of their blood pressure

Table 1: Percentage distribution of subjects according to their anthropometric measurement

Parameters	Post menopause		
	Hypertensive (N = 30)	Normotensive (N=30)	Total (N=60)
Height (cm)	156.36 ± 1.08	153.7 ± 1.05	155.03 ± 0.73
Weight (Kg)	65.2 ± 1.69	60.0 ± 1.10	62.9 ± 1.12
Waist Circumference (cm)	97.52 ± 3.11	90 ± 3.77	93.76 ± 2.42
Abdominal circumference (cm)	96.63 ± 0.99	88.96 ± 0.80	92.79 ± 0.58
Hip circumference (cm)	102.9 ± 1.69	94.31 ± 1.10	98.60 ± 1.12
Triceps skinfold (mm)	23.36 ± 0.75	22.6 ± 1.60	22.98 ± 0.53
Biceps skinfold (mm)	13.25 ± 1.08	11.47 ± 1.05	12.36 ± 0.73
Subscapular skinfold (mm)	25.29 ± 1.62	22.45 ± 1.25	23.87 ± 1.41
Suprailiac skinfold (mm)	26.32 ± 0.23	24.49 ± 1.18	25.40 ± 0.37
Abdominal skinfold (mm)	27.13 ± 3.90	23.90 ± 4.61	25.51 ± 3.08
Calf skinfold (mm)	17.33 ± 0.46	15.50 ± 0.34	16.4 ± 0.29
Body mass index (kg/m ²)	26.55 ± 1.41	25.48 ± 1.30	26.05 ± 0.91

Table 2: Percentage distribution of subjects according to their body fat distribution, body fat pattern and risk of hypertension

Parameters	Post menopause		
	Hypertensive (N=30)	Normotensive (N=30)	Total (N = 60)
Waist hip ratio	0.94 ± 0.52	0.90 ± 0.28	0.92 ± 0.35
Conicity Index	1.38 ± 0.52	1.32 ± 0.28	1.35 ± 0.35
Sum of three trunk folds (mm)	76.2 ± 5.96	70.42 ± 4.72	73.31 ± 3.79
Sum of six skinfolds (mm)	130.82 ± 5.08	119.73 ± 6.48	125.27 ± 4.13
TE ratio	1.41 ± 0.30	1.42 ± 0.26	1.41 ± 0.20
Relative fat pattern index (RFPI)	0.48 ± 0.69	0.47 ± 0.86	0.47 ± 0.53
Systolic blood pressure (mm Hg)	163.63 ± 2.19	130 ± 2.20	146.81 ± 1.57
Diastolic blood pressure (mm Hg)	101.66 ± 1.67	85.4 ± 1.39	93.53 ± 1.09

age, BMI, WHR, CI, TSF₃, SF₆, TE ratio, RFPI, SBP and DBP for hypertensive and normotensive women were presented in tables 3 and 4, respectively. Hypertensive women also had higher waist hip ratio (0.94) compared to normotensive women (0.90) Pelt et al. (2001) in a large cohort of healthy post menopausal women found that waist circumference was significantly associated with high blood pressure. Hypertensive women had higher conicity index, SF₃ and SF₆.

Hypertensive Women: Age was significant and positively associated with systolic and diastolic blood pressure, and not with other variable. Similar result were reported by Giampaoli and Vanuzzo (2002) that prevalence of hypertension increased with increasing age. The change was particularly marked after menopause. Staessen et al. (1997) also stated that menopause was accompanied by a steeper rise in systolic blood pressure with age and diastolic blood pressure was independent of age. BMI had

positive significant ($P < 0.01$) association with TSF₃, SF₆, TE ratio, SBP and DBP. Kawada (2002) and Raskin (2003) reported same results. Huang et al., (1998) reported that higher BMI at post menopausal stage strongly increased the risk of developing hypertension. CI has significant relation ($P < 0.01$) with WHR, SF₆, SBP and DBP. Daniels et al., (1999) reported that a greater deposition of central fat is correlated with blood pressure (Table 3).

Normotensive Women: Age was correlated only with diastolic blood pressure in the variable studied. BMI had positive significant correlation with TSF₃, SF₆, TE ratio and SBP was negatively correlated with BMI. Conicity index had correlation with WHR. RFPI was insignificantly correlated with all the variables. The BMI, WHR, TSF₃ and SF₆ were correlated with each other. SBP and DBP were also significantly inter correlated (Table 4).

The above results indicate that there was a significant positive relationship of age with

Table 3: Pearson's correlation coefficients among age, different adiposity measures and blood pressure in the post menopausal hypertensive women

Variable	Age	BMI	WHR	CI	TSF3	SF6	TE ratio	RFPI	SBP	DBP
Age	-	0.178	-0.203	-0.201	-0.100	-0.063	-0.263	0.124	0.370**	0.425**
BMI	0.178	-	0.102	0.254	0.636*	0.728*	-0.300**	-0.106	0.401**	0.402**
WHR	-0.203	0.102	-	0.602**	0.187	0.171	0.315**	0.218	-0.039	0.084
CI	-0.201	0.254	0.602**	-	0.298	0.406*	0.147	0.093	0.600**	0.500**
TSF ₃	-0.100	0.636	0.187	0.298	-	0.909*	0.385**	0.247	0.279	0.295
SF ₆	-0.063	0.728	0.171	0.406*	0.909*	-	0.204	0.044	0.297	0.388**
TE ratio	-0.263	-0.380**	0.375**	0.147	0.385**	0.204	-	0.470*	0.382**	0.057
RFPI	0.124	-0.106	0.218	0.093	0.247	0.044	0.470*	-	0.064	0.043
SBP	0.370**	0.401**	-0.039	0.600**	0.279	0.297	0.302**	0.064	-	0.752*
DBP	0.425**	0.402**	0.084	0.500**	0.295	0.388**	0.057	0.043	0.752*	-

Two-tailed significance ** P<0.05, * P<0.01

Table 4: Pearson's correlation coefficients among age, different adiposity measures and blood pressure in the post menopausal normotensive women

Variable	Age	BMI	WHR	CI	TSF3	SF6	TE ratio	RFPI	SBP	DBP
Age	-	0.146	0.115	-0.075	0.062	-0.074	0.249	0.047	-0.081	-0.377**
BMI	0.146	-	0.153	0.227	0.653*	0.614*	0.532*	0.186	-0.362**	-0.131
WHR	0.115	0.153	-	0.430**	-0.087	-0.201	-0.026	0.195	-0.108	-0.118
CI	-0.075	0.227	0.430**	-	0.108	0.127	0.064	-0.061	-0.102	-0.153
TSF3	0.062	0.653*	-0.087	0.108	-	0.855*	0.541*	0.213	-0.377**	-0.090
SF6	-0.074	0.614*	-0.201	0.127	0.855*	-	0.369**	0.187	-0.186	0.022
TE ratio	0.249	0.532*	-0.026	0.064	0.541*	0.369**	-	-0.122	-0.434**	-0.240
RFPI	0.047	0.186	0.195	-0.061	0.213	0.187	-0.122	-	0.018	-0.251
SBP	-0.081	-0.362**	-0.108	-0.102	-0.377**	-0.186	-0.434**	0.018	-	0.535*
DBP	-0.377**	-0.131	-0.118	-0.153	-0.090	0.022	-0.240	-0.251	0.535*	-

Two-tailed significance ** P<0.05, * P<0.01

systolic blood pressure and diastolic blood pressure among the hypertensive women at post menopausal stage while normotensive women had positive relationship only with diastolic blood pressure (DBP). Staessen et al. (1997) also reported that post menopausal women had a higher systolic and diastolic blood pressure. BMI had a positive and significant relationship with systolic and diastolic blood pressure except diastolic blood pressure of normotensive women. Ishikawa (2002) reported that BMI increase beyond 22 kg/m² was related to an increased risk for hypertension.

WHR was not found to be strongly associated with blood pressure in the study group. Conicity index was significantly correlated with SBP and DBP in hypertensive women. It might be due to the fact that the abdominal adiposity and subcutaneous adipose tissue were higher in hypertensive women compared to normotensive women. The sum of TSF₃, SF₆ and the TE ratio

were intercorrelated with others in both groups. The systolic and diastolic blood pressure were also intercorrelated with each other in both groups.

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