Dynamics of Body Fat and Circumferences in Post Menopausal Women of Chandigarh, India

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INTRODUCTION

Aging is associated with a number of adverse changes in body composition and body build. With advancing age during the later years of life, the mass of fat-free tissue decreases whereas that of the fat tissue increases (Skerlj et al., 1953). Weight gain particularly after the menopause transition seems to be a universal phenomenon (Wing et al., 1991). During reproductive years, there is a more gynoid type of fat distribution among women (Rebuffe-Scrive et al., 1985). This is chracterised by less amount of fat on trunk but greater amount of fat tissue in the hip, gluetal and femoral region. After the menopause, the more gynoid fat distribution may change towards an android-type of fat distribution with greatest amount of fat tissue in the abdominal region (Ley et al., 1992). Kirchengast et al. (1997) also supported the presence of gynoid type of fat distribution in post-menopausal women, whereas, Pasquali et al. (1994) suggested that the menopausal status could slightly but significantly increase body weight, without affecting body fat distribution. Tchernof and Poehlman (1998) observed that central body fatness is increased significantly at menopause, independent of advancing age.

Prospective follow up studies of dynamics of body fat during and after menopause show increasing amounts of total and central abdominal fat and decreasing amounts of lean muscle tissue (Poehlman et al., 1995 and Svendson et al., 1995). According to Rebuffe-Scrive et al. (1987), this redistribution of body fat during and after menopause may be attributed to the effects of estrogen deficiency on adipocyte metabolism leading to differential fat patterning.

Body fat distribution is a more important determinant of disease risk than simple increase in body mass. Individuals with a higher proportion of abdominal fat seem to have a greater risk of developing type-2 diabetes mellitus (Ohlson et al., 1985; Seidell and Flegal, 1997), coronary artery disease (Rexrode et al., 1998) and cardio-vascular disease related mortality (Folsom et al., 2000).

Increased central adiposity in women perhaps is a better predictor of heart disease, diabetes and death than generalized obesity (Manson et al., 1995). Abdominal adiposity tends to increase with advancing age. Several studies have reported an increasing WHR with age (Jones et al., 1986; Marti et al., 1991). From two studies with very large samples on Taiwanese by Huang et al. (2002) and on Chinese by Zhou (2002) it was found that with increasing body mass index and waist circumference, there were significantly higher risks of hypertension, impaired fasting glucose, diabetes and dyslipidemia. Björntorp (1985) found that waist-to-hip ratio as an index of body fat distribution was significantly associated with diabetes and hypertension and gall-bladder disease in older women and with menstrual abnormalities in the younger women. Associations of fat distribution with disease has been found by many authors in different populations (Seidell et al., 1987; Hartz et al., 1984; Newberry et al.,1990; Friedman et al., 1990; Sakurai et al., 1995; Raikkonen et al., 1999; Yasmin and Mascie-Taylor 2000; Chang et al., 2000).

There is a growing concern across the globe to investigate the populations periodically to study the risk patterns especially from the viewpoint of fat patterning. A recent search of literature on this aspect reveals almost a complete absence of information on the fat patterning amongst post-menopausal women of North Indian origin representing different socio-economic strata. Present study has been undertaken with the objective of exploring the fat patterning amongst post-menopausal women aged 50-60 years belonging to upper and lower socio-economic strata of Chandigarh, India.

MATERIAL AND METHODS

The present study is based on a cross-sectional sample of 600 post-menopausal women ranging between 50 to 60 years of age belonging to Upper and Lower Socio-Economic Strata taken during 2002-04 from Chandigarh (Union Territory). The household maids and other women engaged in menial jobs formed the lower SES group. Those

women who had an educational level of graduation and above and had personal occupation with high incomes or others who were from business families where family income was very high were included in the upper SES group. Anthropometric measurements which included weight and height, circumferences and skinfolds were taken on each subject by the first author (DM) following the techniques of Lohman et al., 1988). Waist-to-hip ratio is associated with intra-abdominal fat than with the subcutaneous fat and is often used as an indicator of fat distribution. Waist-to-Hip ratio is also good indicator of various disease risk associated with it which is calculated as follows:

WHR = Waist circumference (cm)/ Hip circumference (cm)

Accordingly, values of WHR ranging from 0.80 to 0.90 cm in women have been defined as critical (Willett et al., 1999).

The body density has been calculated from skinfolds using equations by Durnin and Womersley (1974) which was later converted into the percentage body fat with the formula given by Siri (1961).

RESULTS

The age range of the sample (from 50 to 60 years)was 10 years which was further divided into 2 groups of 5-yearly duration in both upper and lower socio-economic strata. Post-menopausal women of upper SES are significantly heavier and taller in the age group 50-54 yrs and 55-60 years as compared to those of the lower SES (Table 1). However, post-menopausal women of upper SES have shown slight decrease in weight as compared to a slight increase in it in case of lower SES women between the age groups of 50-54 years and 55-60 years.

In order to find out how the various body dimensions undergo changes after the onset of menopause among women aged 50 to 60 years, varied durations after the onset of menopause have been considered. Table 2 shows a trend of general increase in body weight in post-menopausal women of upper and lower SES with progression of *years after onset of menopause* (Y.A.O.M.). This has not been the case when age matching was taken into consideration (Table 1). As the years after onset of menopause progress, post-menopausal women of upper SES have shown significantly greater body weight than that of the lower SES women.

The post-menopausal women of upper socio-economic strata have observed decrease in their circumferences with age, whereas post-menopausal women of lower socio-economic strata have shown an increase in case of waist and abdomen circumference from the age group of 50-54 years to 55-60 years (Table 3).

Table 4 and 5 present the statistics of body

Table 1: Weight (kg) and Height (cm) of upper and lower socio-economic strata Post- menopausal women in the age group of 50-54 yrs and 55-60 yrs.

	Upper SES			*Lower SES*			*t-value*
Variable	*X*	*S.E.M.*	*S.D.*	*X*	*S.E.M.*	*S.D.*	
Age group 50-54 years							
Weight (kg)	64.7	1.13	11.37	52.9	0.61	7.09	9.19*
Height (cm)	157.0	0.36	3.62	153.4	0.31	3.55	7.57*
Age group 55-60 years							
Weight (kg)	63.4	0.73	10.26	53.9	0.60	7.79	10.05*
Height (cm)	156.3	0.29	4.1	154.2	0.33	4.26	4.78*

*p<0.05

Table 2: Weight (kg) of post-menopausal women of upper and lower SES in years the onset of menopause (Y.A.O.M.)

Y.A.O.M.	*Upper SES*			*Lower SES*			*t-value*
	X	*S.E.M.*	*S.D.*	*X*	*S.E.M.*	*S.D.*	
2-3 yrs	64.6	1.22	11.14	50.6	1.71	5.92	6.67*
4-5 yrs	61.5	1.03	9.84	49.7	1.12	5.73	7.75*
6-7 yrs	63.6	1.04	9.09	53.3	0.92	7.06	7.41*
8-9 yrs	68.0	1.93	10.93	53.9	1.03	8.16	6.44*
10-11 yrs	68.1	3.84	15.35	54.9	0.93	7.65	3.34*
12-13 yrs	-	-	-	53.6	0.88	7.52	-

*p<0.05

circumferences in upper and lower SES women, respectively according to years after the onset of menopause. There is a perceptible shift towards increasing values of waist and abdomen circumferences in both upper and lower class women with the progression of years after the onset of menopause (Figs. 1, 2).

The post-menopausal women of upper SES have shown significantly larger values than the lower SES women for most of the circumferences

Table 3: Circumferences (cm) of upper and lower Socio-Economic Strata Post- menopausal women in the age- group of 50-54 yrs and 55-60 yrs.

	Upper SES			*Lower SES*			*t-value*
Variable	*X*	*S.E.M.*	*S.D.*	*X*	*S.E.M.*	*S.D.*	
Age group 50-54 yrs							
Waist (cm)	84.7	0.96	9.65	78.7	0.66	7.61	5.14*
Hip (cm)	100.2	0.95	9.55	95.6	0.52	6.06	4.25*
Thigh (cm)	51.4	0.33	3.33	50.2	0.26	3.07	2.83*
Abdomen (cm)	95.8	0.95	9.64	94.1	0.70	8.11	1.44
Calf (cm)	38.4	0.28	2.86	38.0	0.24	2.76	1.07
Arm (cm)	30.2	0.36	3.59	28.1	0.28	3.23	4.58*
Age group 55-60 yrs							
Waist (cm)	83.7	0.69	9.66	79.7	0.64	8.24	4.24*
Hip (cm)	98.9	0.65	9.16	95.5	0.53	6.8	4.06*
Thigh (cm)	51.2	0.2	2.83	50.3	0.24	3.05	2.85*
Abdomen (cm)	95.6	0.76	10.65	95.7	0.69	8.84	0.10
Calf (cm)	38.4	0.2	2.81	37.7	0.23	2.99	2.33*
Arm (cm)	29.9	0.22	3.08	28.6	0.33	4.25	3.25*

*p<0.05

Table 4: Circumferences (cm) of post-menopausal women of upper socio-economic strata after the onset of menopause.

Y.A.O.M.	*X*	*S.E.M.*	*S.D.*	*X*	*S.E.M.*	*S.D.*	*X*	*S.E.M.*	*S.D.*
Variable	*Waist (cm)*			*Hip (cm)*			*Thigh (cm)*		
2-3 yrs	84.5	1.02	9.32	100.0	0.98	8.97	51.5	0.39	3.51
4-5 yrs	81.5	1.04	9.97	97.3	0.97	9.32	50.6	0.27	2.62
6-7 yrs	84.8	0.93	8.20	99.4	0.92	8.09	51.4	0.28	2.5
8-9 yrs	88.5	1.61	9.13	103.2	1.77	10.0	52.6	0.48	2.71
10-11 yrs	87.2	3.25	13.0	102.9	3.09	12.4	51.3	0.98	3.91
Variable	*Abdomen (cm)*			*Calf (cm)*			*Arm (cm)*		
2-3 yrs	95.9	1.04	9.43	38.6	0.31	2.78	30.1	0.41	3.70
4-5 yrs	92.7	1.10	10.6	38.0	0.35	3.35	29.5	0.32	3.09
6-7 yrs	96.6	1.11	9.78	38.6	0.26	2.24	30.0	0.31	2.76
8-9 yrs	101.2	1.74	9.85	39.4	0.4	2.24	30.6	0.57	3.21
10-11 yrs	98.9	2.90	11.6	38.2	0.78	3.10	31.0	0.96	3.84

Table 5: Circumferences (cm) of post-menopausal women of Lower socio-economic strata after the onset of menopause.

Y.A.O.M.	*X*	*S.E.M.*	*S.D.*	*X*	*S.E.M.*	*S.D.*	*X*	*S.E.M.*	*S.D.*
Variable	*Waist (cm)*			*Hip (cm)*			*Thigh (cm)*		
2-3 yrs	76.1	1.70	5.88	95.8	1.15	3.97	49.1	0.50	1.72
4-5 yrs	76.1	1.22	6.20	95.2	0.99	5.06	49.0	0.45	2.28
6-7 yrs	78.7	1.08	8.33	95.1	0.87	6.65	50.2	0.42	3.26
8-9 yrs	80.1	0.97	7.69	95.8	0.82	6.53	51.0	0.40	3.14
10-11 yrs	81.2	0.99	8.13	96.8	0.79	6.5	50.4	0.36	2.98
12-13 yrs	79.0	0.96	8.24	94.6	0.82	6.99	50.3	0.38	3.21
Variable	*Abdomen (cm)*			*Calf (cm)*			*Arm (cm)*		
2-3 yrs	91.6	1.05	3.64	37.6	0.48	1.67	26.5	0.51	1.75
4-5 yrs	90.8	1.08	5.52	36.9	0.39	1.97	27.1	0.31	1.60
6-7 yrs	93.8	1.11	8.55	37.8	0.33	2.55	28.5	0.42	3.25
8-9 yrs	96.0	1.14	9.08	38.6	0.39	3.13	28.0	0.53	4.20
10-11 yrs	97.0	1.06	8.70	38.2	0.35	2.86	29.2	0.52	4.23
12-13 yrs	95.3	1.03	8.77	37.2	0.37	3.19	28.6	0.49	4.15

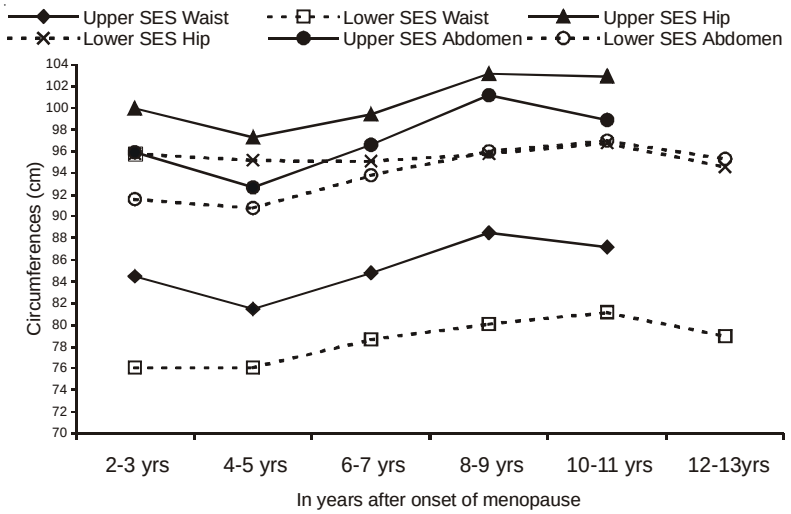

Fig. 1. Circumferences of Post-menopausal women of upper and lower SES after the onset of menopause.

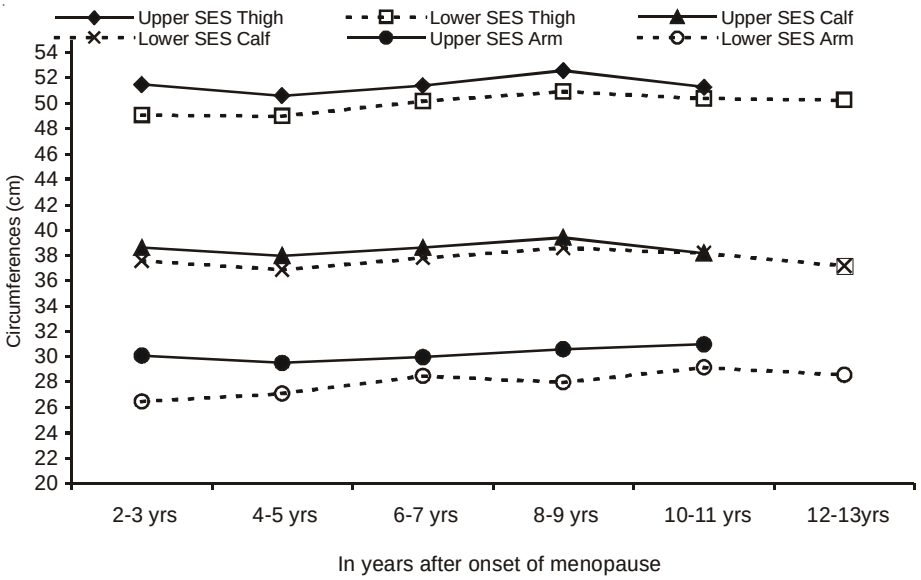

Fig. 2. Circumferences of Post-menopausal women of upper and lower SES after the onset of menopause.

Table 6: Differences in circumferences between upper and lower socio-economic groups women (t-values)

Y.A.O.M.	*Waist (cm)*	*Hip (cm)*	*Thigh (cm)*	*Abdomen (cm)*	*Calf (cm)*	*Arm (cm)*
2-3 yrs	4.24*	2.78*	3.78*	2.91*	1.75	5.50*
4-5 yrs	3.37*	1.52	3.05*	1.23	2.10*	5.39*
6-7 yrs	4.28*	3.40*	2.38*	1.78	1.9	2.87*
8-9 yrs	4.47*	3.79*	2.62*	2.50*	1.43	3.34*
10-11 yrs	1.77	1.91	0.86	0.62	0.00	1.65

*$p<0.05$

Table 7: Disease risk from waist to hip ratio (WHR) for women belonging to upper SES.

Disease risk (WHR range)	*Years after onset of menopause*									
	2-3 yrs		*4-5 yrs*		*6-7 yrs*		*8-9 yrs*		*10-11 yrs*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Very low ≤0.80	11	13.3	19	20.7	7	9.1	4	12.5	3	18.8
Low 0.81-0.84	27	32.5	25	27.2	22	28.6	6	18.8	3	18.8
High ≥0.85	45	54.2	48	52.2	48	62.3	22	68.8	10	62.5

Table 8: Disease risk from waist to hip ratio (WHR) for women belonging to lower SES after the onset of menopause.

Disease risk	*Years after onset of menopause*											
	2-3 yrs		*4-5 yrs*		*6-7 yrs*		*8-9 yrs*		*10-11 yrs*		*12-13 yrs*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Very low	10	83.3	17	65.4	20	34.5	19	29.2	15	22.4	22	30.6
Low	1	8.3	7	26.9	19	32.8	16	24.6	21	31.3	21	29.2
High	1	8.3	2	7.7	19	32.8	30	46.2	31	46.3	29	40.3

Table 9: Density, % Body Fat, TBF and LBM of post-menopausal women belonging to upper and lower SES after the onset of menopause.

Variable	*Upper S.E.S.*			*Lower S.E.S.*			
Y.A.O.M.	*X*	*S.E.M*	*S.D.*	*X*	*S.E.M*	*S.D.*	*t-value*
Density							
2-3 yrs	1.029	0.001	0.01	1.045	0.001	0.004	14.14*
4-5 yrs	1.030	0.001	0.01	1.042	0.001	0.004	9.88*
6-7 yrs	1.028	0.001	0.01	1.040	0.001	0.01	7.07*
8-9 yrs	1.027	0.001	0.01	1.039	0.001	0.01	7.07*
10-11 yrs	1.026	0.002	0.01	1.038	0.001	0.01	4.47*
12-13 yrs	-	-	-	1.038	0.01	0.07	-
Percentage Body Fat							
2-3 yrs	31.21	0.29	2.66	23.66	0.48	1.66	13.46*
4-5 yrs	30.54	0.25	2.42	24.95	0.35	1.78	12.96*
6-7 yrs	31.43	0.25	2.17	25.99	0.33	2.53	13.14*
8-9 yrs	31.96	0.43	2.43	26.10	0.35	2.81	10.57*
10-11 yrs	32.43	0.84	3.35	27.03	0.38	3.08	5.86*
12-13 yrs	-	-	-	26.83	0.35	2.99	-
Total Body Fat							
2-3 yrs	20.42	0.60	5.49	12.00	0.54	1.88	10.38*
4-5 yrs	18.99	0.46	4.43	12.45	0.40	2.05	10.67*
6-7 yrs	20.17	0.49	4.27	13.99	0.39	2.99	9.93*
8-9 yrs	21.97	0.89	5.05	14.25	0.44	3.53	7.75*
10-11 yrs	22.50	1.74	6.96	15.01	0.43	3.54	4.18*
12-13 yrs	-	-	-	14.56	0.41	3.46	-
Lean Body Mass							
2-3 yrs	68.79	0.29	2.66	76.34	0.48	1.66	13.47*
4-5 yrs	69.46	0.25	2.42	75.05	0.35	1.78	12.96*
6-7 yrs	68.57	0.25	2.17	74.01	0.33	2.53	13.21*
8-9 yrs	68.04	0.43	2.43	73.90	0.35	2.81	10.53*
10-11 yrs	67.57	0.84	3.35	72.97	0.38	3.08	5.88*
12-13 yrs	-	-	-	73.17	0.35	2.99	-

*$p<0.05$

when the comparisons are made for matched duration of the years after the onset of menopause except for the duration of 10-11 years (Table 6).

Disease risk prediction from Waist Hip Ratio (WHR) indicates that as the years after menopause progress, the proportion of women in high risk category (WHR > 0.85) also increases in both the groups under study (Tables 7, 8). More than 50% of upper SES women were already in high risk category compared to less than 10% in lower SES women up to 5 years after menopause. This risk increases manifold in lower SES women with the

progression of years after menopause, however, compared to their upper SES counterparts, this risk was still considerably lower.

A trend of increase in percentage of body fat has taken place in the post-menopausal women of lower SES as the years after menopause increased, however, women from upper SES have shown comparatively higher values of % body fat than lower SES women (Table 9).

DISCUSSION

Waist girth and WHR are two anthropometric indicators most commonly used for the prediction of visceral adipose tissue. WHR has been widely used in epidemiologic studies, which has been associated with an increased risk of cardio-vascular disease and NIDDM (Larsson et al., 1984 and Ohlson et al., 1985).

Using these indicators of disease risk in the present study, it is found that post-menopausal women of both upper and lower socio-economic strata have indicated elevated disease risk. The risk prevalence is much higher in post-menopausal women of upper SES as compared to women of lower SES.

Post-menopausal women of the present study of upper socio-economic strata with 39.0% compared to 19.3 % of those in lower are more inclined towards disease risks like CVD associated with increased waist circumference. Deurenberg-Yap et al. (2002), studied relationship of elevated body fat percentage and cardio-vascular risks even at lower body mass index levels among Singaporean, Chinese, Malays and Indians. All the ethnic groups exhibited lower categories of BMI (between 22 and 24 kg/ m^2) and waist circumference (between 75 and 80cm for women and between 80 and 85 cm for men), but had higher risks which were much more as compared to the western populations. If these findings are substantiated, then the scientists would be compelled to reframe the ranges for the Asians different from those of the westerners especially in case of the abdominal fat, various indices and circumferences. WHO has already recommended using new ranges for designating normal in Asian populations with BMI between 18.5 up to 22.99 instead of the conventional 18.5 to 24.99 as given by Choo (2000).

Waist-to-Hip ratio has shown prevalence of high disease risk in the post-menopausal women of upper socio-economic strata where more than 50% of the studied sample was found to be under this category. Post-menopausal women of lower socio-economic strata have also shown tendency towards high-risk category with their percentage increasing from 8.3% to 46.3% with the increase in years after menopause. Post-menopausal women of both upper and lower socio-economic strata have shown a significant shift towards predominance of upper body fat with advancing years after menopause as per classification of WHR given by Hartz et al. (1984). Accordingly, the values of WHR less than 0.73 indicate lower body fat predominance and values above 0.80 indicate upper body fat predominance. Post-menopausal women of the present study of upper socio-economic strata have shown predominance of upper body fat with 85.0% falling under the category of WHR >0.80, whereas post-menopausal women of lower socio-economic strata have 65.3% cases in this category of upper fat distribution and only 1.3% have shown predominance of lower body fat distribution. Mishra et al. (2001) studied urban slum population of Delhi where WHR was found to be higher even in case of slum females indicating increasing abdominal adiposity. According to this study, the prevalence of obesity in the poor is more prevalent in the female sex and is also linked to disease. Han et al. (1997), has identified that the people with larger waist circumference are at increased risk of cardio-vascular diseases and is not influenced by height.

De Vegt et al. (2001), in the Hoorn Study observed that waist-to-hip ratio (WHR) and not body mass index (BMI) is an important independent predictor of incident of diabetes in 50–75-yr-olds. Rosenthal et al., (2004) studied and observed that with increasing central obesity the risk of diabetes also increased in the Chinese women aged 40-70 year with low WHR during early years. Canoy et al. (2004) observed that in European populations WHR was related to blood pressure independent of BMI and age. Lean et al. (1995) proposed an interesting hypothesis of action on the basis of waist circumference: avoid weight gain or weight loss (if WC more than 94 cm in men and 80 cm in women) and should seek help from health professional (if WC is more than 102.0 cm in men and 88.0 cm in women) as they have a strong likelihood of developing several disorders, including shortness of breath, hypertension and major cardiovascular disorders.

Circulating sex steroids can influence body fat distribution (Lindsay, 1987), and a trend to a progressive increase in body weight is often observed throughout the climacteric period. Keys et al. (1991) in their study on fat distribution and sex hormone concentration indicated that in post-menopausal women abdominal adiposity is associated with relatively more androgenic sex

hormone profile. Espeland et al. (1997) and Gambacciani et al. (1997) suggested that it is declining sex hormones rather than aging that trigger the menopause related increase in abdominal adiposity and the unfavorable changes in metabolic profile. A conclusive shift seems to take place in upper and lower social strata women of the present study towards the abdominal adiposity as they are moving away from menopause.

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KEYWORDS Circumferences. Body Weight. Abdominal Fat. Adiposity

ABSTRACT Present study has been undertaken with the objective of exploring the fat patterning amongst 600 post-menopausal women aged 50-60 years belonging to upper and lower socio-economic strata of Chandigarh, India. The household maids and women engaged in menial jobs formed the lower SES group. Women with high incomes or those who were from business families were included in the upper SES group. Anthropometric measurements which included weight and height, circumferences and skinfolds were taken on each subject by the first author (DM). Post-menopausal women of the present study with 39.0% of the cases in upper socio-economic strata compared to 19.3 % in lower SES were more inclined towards disease risks like CVD on the basis of increased waist circumference. Waist-to-Hip ratio has shown prevalence of high disease risk in the post-menopausal women of upper socio-economic strata with more than 50% of the studied sample found to be under this category. Post-menopausal women of lower socio-economic strata have also shown tendency towards high-risk category with their percentage increasing from 8.3% to 46.3% with the increase in years after menopause. There is a perceptible shift towards increasing values of waist and abdomen circumferences in both upper and lower class women with the progression of years after the onset of menopause. A trend of increase in percentage of body fat has taken place in the post-menopausal women of lower SES as the years after menopause increased, however, women from upper SES have shown comparatively higher values of % body fat than lower SES women.

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