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Body Composition and Fat Distribution Pattern of Urban Elderly Females, Delhi, India

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A B S T R A C T

The present study was conducted on females (n=279) in the age range of 51–89 year, living in the urban dwellings of Delhi, India. Another group of 21–25 years old young adult females was taken as a control group. A total of 14 anthropometric measurements were taken: stature, sitting height, weight, skinfold thickness at nine different sites over the body and body girths such as upper arm, waist and hip circumference. Indices like body mass index, grand mean thickness, waist-hip ratio were computed to assess the body composition. Fat profile and responsiveness of different skinfold sites towards fat accumulation were studied to find out the regional fat distribution with advancing age. Redistribution of body fat was found to take place with increasing age. A relative preponderance of upper body fat was visible among elderly subjects. However, a clear reverse trend was observed in the young control group females. Significant differences were observed with regards to the body composition and fat profile between young adult females and test group females. Abdomen and the sub-scapular area were reported to be the most sensitive sites for fat deposition as the age advanced. The stature and sitting height showed significant decline with age. All the indices of adiposity i.e. grand mean thickness, waist-hip ratio and body mass index revealed significant changes in elderly females when compared with young adult control group females.

Key words: *adiposity, anthropometry, fat profile, elderly females*

Introduction

Body composition i.e. the relative and absolute amount of lean body mass and depot fat is one of the most variable characteristics of an organism. It undergoes changes throughout the life not only in relation to growth, development and ageing but above all in relation to caloric balance and energy turnover in the organism per unit of time. Body composition is affected by age, sex, population, genes and numerous environmental[1] and behavioural factors[2].

Researches on adult body composition revealed that all the major tissues of the body undergo considerable alteration with age. A decline in lean body mass[3] and a simultaneous increase in fat mass during adulthood has been shown using variety of techniques[4–8]. The proportion of fat in the body has been found be to higher in older age groups as compared to young adult individuals in different studies[4,9,10]. Pollock et al.[11] found highest prediction of body fat by using combination of skinfold thickness, girth, diameters and cup size among middle aged women of 33–52 years of age. Satwanti et al.[12] reported ethnic variation in prediction of body composition among women of European descent. The studies on the fat distribution pattern and its changes among elderly population are scanty in the Asian population especially in India.

The aim of present study is to assess the fatness level, regional distribution of fat and the sensitivity of different skinfold sites towards fat accumulation among females with advancing age using the simple and non-invasive anthropometric techniques. Most of the methods to assess body composition are complicated and need skilled personnel and costly equipments available only in the laboratories. As these methods cannot be used in the field, more practical and simple method need to be explored to assess body composition. The anthropometric measurements can provide information on gross body size, skeletal forms or configuration and on skeletal and soft tissues development[13.] and also on the secular changes in the body dimensions[14,15]. Anthropometric methods can be used as an alternative method to assess body composition under the field conditions.

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Materials and Methods

The present study was carried out in the urban dwellings of Delhi, capital of India. A total of 279 females were selected exclusively on voluntary basis. This includes a group of 30 young adult females of age range 20–24 years that were treated as control group. Two hundred and forty nine elderly females in the age range of 51 to 70 years were studied and treated as test groups. The test group elderly females were sub-grouped into 8 different age groups namely 51–55 years, 56–60 years, 61–65 years, 66–70 years. The survey was conducted from August 2000 to September 2001.

A pilot survey was conducted prior to the main study in order to standardize the techniques used. A door-to-door, cross sectional survey was carried out to collect the anthropometric data along with the information regarding their personal details and life style. All the subjects belonged to one ethnic group i.e. Khattri (a Punjabi speaking endogamous population). All the subjects were from middle class category with an annual income ranging between 84,000–150,000 rupees (Rs.). All of them were vegetarians and had three meals a day. About ten percent of the total sample included salad and fruits in their daily diet.

Only 40 percent of the total sample was literate i.e. had education up to primary level. Eighty five percent (85%) maintained a regular physical activity level by morning walk besides helping in daily household activities. The average age at marriage was 15.5±2.2 years. The average age at menopause was 49.7±1.2 years.

All the subjects were measured before noon i.e. prior to their lunch. A good reproducibility coefficient was obtained for different measurements taken on two consecutive days. All the subjects were personally interviewed. The age was recorded according to birth certificate, comparisons with their birth cohorts, confirmation from family members and by recollection of significant socio-cultural and historical events. Only physically normal subjects were included in the present study. All the subjects were explained about the nature of research in advance before starting up the actual study.

All the instruments were calibrated using recommended techniques of Weiner and Lourie[16] prior to use. A total of 14 anthropometric measurements were taken on all the subjects. The stature and sitting height were measured by anthropometer to nearest 1.0 mm. The body weight was measured using beam-weighing machine. Skinfold thickness were taken at nine different sites namely biceps, triceps, abdomen, subscapular, supra-iliac, medial calf, posterior calf, lateral calf and thigh anterior using Holtain skinfold caliper to the nearest 0.2 mm (exerting a constant pressure of 10gm/mm^2 on the contact surface). Body circumferences i.e. upper arm, waist and hip were measured with Freeman's steel tape to the nearest 1.0 mm.

The body mass index (BMI) was calculated as the ratio of weight in kg divided by height in m^2. Grand mean thickness (GMT) was calculated as mean of sum of all the nine skinfold thickness. It gives gross mean value of skinfold thickness taken over the body. Waist hip ratio (WHR), a measure of regional fat distribution was computed by dividing waist circumference by hip circumference.

Sensitivity of nine skinfold sites towards accumulation of fat was studied as the relative subcutaneous fat pattern i.e. by expressing each skinfold thickness as percent of GMT. This procedure eliminates differences solely due to total amount of subcutaneous fat and permits intergroup comparison of the proportion of skinfold thickness at different sites[14].

The mean and standard deviation values were computed using the statistical package for social sciences (SPSS) by an IBM compatible computer

Indirect estimation of fat percentage and fat free mass using the regression equations was not undertaken as it has been reported by the earlier workers that such regression equations are specific for age, gender and ethnicity[10,18,19].

Results

The basic data for all the subjects is shown as Table 1. The mean values of stature and sitting height were

TABLE 1
BASIC DATA OF ADULT FEMALES

Age Groups (years)	21–25	51–55	56–60	61–65	66–70	71–75	76–80	81–85	86+
Number of subjects	30	32	26	39	38	37	35	22	20
Stature (cm)	154.4 ± 4.3	150.9 ± 6.0	151.5 ± 6.9	149.3 ± 6.4	147.8 ± 6.0	146.4 ± 5.8	146.4 ± 6.4	145.2 ± 6.5	142.4 ± 5.4
Sitting Height (cm)	82.1 ± 3.6	77.8 ± 5.2	77.0 ± 3.7	76.3 ± 4.0	75.9 ± 4.6	75.8 ± 4.3	73.7 ± 4.1	72.3 ± 6.5	71.9 ± 4.3
Weight (kg)	49.8 ± 7.2	61.2 ± 12.2	54.3 ± 12.2	57.9 ± 11.7	58.6 ± 13.7	54.4 ± 12.9	52.9 ± 10.5	48.3 ± 8.8	46.9 ± 12.9
Waist circumference (cm)	69.5 ± 6.4	83.4 ± 9.8	79.6 ± 10.1	84.5 ± 8.9	86.2 ± 12.1	83.9 ± 11.0	86.5 ± 9.8	83.2 ± 9.5	82.2 ± 14.6
Hip circumference (cm)	89.9 ± 7.5	100.9 ± 10.3	93.6 ± 8.9	101.2 ± 10.6	101.0 ± 12.1	98.2 ± 12.4	98.2 ± 10.6	94.7 ± 1.9	94.2 ± 14.2

TABLE 2
THICKNESS OF DIFFERENT SKINFOLD SITES AMONG ADULT FEMALES

Age Groups (years)	21–25	51–55	56–60	61–65	66–70	71–75	76–80	81–85	86+
Biceps SF (mm)	7.1±3.1	12.3±5.4	9.5±4.8	10.5±5.4	10.4±5.3	8.4±4.6	8.0±3.7	6.5±3.5	5.8±3.6
Triceps SF (mm)	13.5±5.9	20.9±7.0	17.6±7.0	17.6±5.8	18.9±6.7	16.1±6.5	15.9±6.0	14.5±7.4	13.4±6.5
Abdomen SF (mm)	16.8±6.2	28.1±9.4	23.2±9.2	23.6±6.5	24.1±8.0	21.7±7.9	20.9±6.9	18.3±5.6	17.8±8.6
Sub-scapular SF (mm)	10.4±3.9	20.5±7.2	15.6±6.0	17.3±6.2	17.6±6.4	15.1±6.1	14.6±5.77	13.7±7.34	11.9±5.83
Supra-iliac SF (mm)	11.5±3.10	18.5±6.72	14.1±5.76	15.3±5.01	16.5±6.50	14.1±5.43	13.3±3.7	11.6±4.2	10.3±4.6
Calf posterior SF (mm)	15.4±4.5	20.3±8.4	16.8±7.2	17.1±6.0	17.6±7.3	15.9±7.3	16.9±5.6	15.1±9.2	15.8±8.6
Calf lateral SF (mm)	13.3±4.3	16.6±7.0	13.6±5.9	15.3±6.1	15.1±7.2	13.5±6.7	14.4±6.0	12.7±6.7	14.3±7.4
Calf medial SF (mm)	14.7±4.9	19.4±6.6	15.7±6.5	17.1±6.5	17.2±8.4	14.8±7.1	16.0±6.1	14.6±7.1	15.4±8.4
Thigh SF (mm)	22.6±6.7	30.4±7.6	26.2±8.8	26.9±7.5	26.9±7.7	25.3±6.9	23.1±7.8	21.6±8.7	20.2±8.4

SF – skinfold thickness

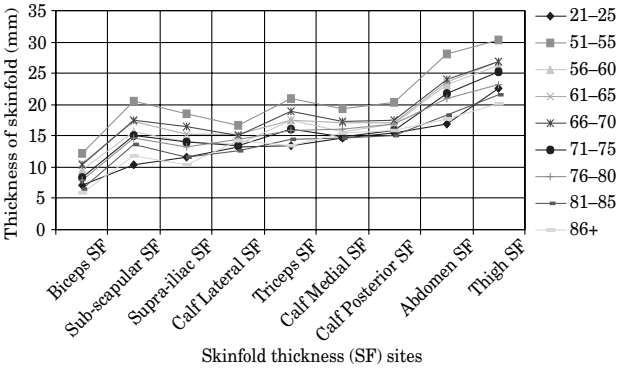

Fig. 1. Fat distribution profile among adult females.

found to be highest in young adult females as compared to rest of the test group females. These differences were found to be statistically significant ($p<0.001$). Both variables, stature as well as sitting height showed a continuous decline with advancing age.

Maximum value for the weight was found in 51–55 years females. The females of 86–90 years of age were found to be lightest as compared to rest of the females. A continuous decline was found after 75 years of age. Upper arm circumference showed highest values in 51–55 years females and lowest in control group females.

Table 2 shows mean and standard deviation of different skinfold thickness in order to study subcutaneous fatness level among females. Highest values for all the skinfold thickness were obtained in 51–55 years females, however, the lowest values were reported in 81–85 years (CFP, CFL, CFM), 86–90 years (BSF, TSF, CSF, THSF) and control group females (ABSF, SCSF, SUSF).

The fat distribution pattern was analyzed by arranging the skinfold sites in an ascending order of their thickness (Figure 1). The ranking of absolute skinfold thickness for control group and test group females at different sites is as follows

21–25 years	BSF < SCSF < SUSF < CFL < TSF < CFM < CFP < ABSF < THSF
51–55 Years	BSF < CFL < SUSF < CFM < CFP < SCSF < TSF < ABSF < THSF
56–60 Years	BSF < CFL < SUSF < SCSF < CFM < CFP < TSF < ABSF < THSF
61–65 Years	BSF < CFL = SUSF < CFP = CFM < SCSF < TSF < ABSF < THSF
66–70 Years	BSF < CFL < SUSF < CFM < CFP = SCSF < TSF < ABSF < THSF
71–75 Years	BSF < CFL < SUSF < CFM < SCSF < CFP < TSF < ABSF < THSF
76–80 Years	BSF < SUSF < CFL < SCSF < TSF < CFM < CFP < ABSF < THSF
81–85 Years	BSF < SUSF < CFL < SCSF < TSF < CFM < CFP < ABSF < THSF
86 + years	BSF < SUSF < SCSF < TSF < CFL < CFM < CFP < ABSF < THSF

Biceps skinfold thickness (BSF) remained the site of minimum fat deposition whereas thigh was reported to be the site of maximum fat deposition in all the age groups including young adults.

The values for the indices of adiposity namely WHR, BMI, GMT are shown in Table 3. The waist-hip ratio was found to be higher in all the test group females as compared to the control group females. The body mass index (BMI) was found to be highest in 51–55 years and 66–70 years age group. The test group subjects as such had higher values of BMI as compared to the young controls.

Table 4 shows the response of different skinfold sites towards accumulation of body fat expressed as percentage of the Grand mean thickness (GMT). The sites for the purpose are displayed in an ascending order of their thickness (Figure 2).

Discussion

The young adult females were found to be significantly taller and had higher value of sitting height as compared to elderly females, 51 years and above. The

TABLE 3
INDICES OF ADIPOSITY AMONG ADULT FEMALES

Age Groups (years)	21–25	51–55	56–60	61–65	66–70	71–75	76–80	81–85	86+
Number of subjects	30	32	26	39	38	37	35	22	20
Body Mass Index, BMI, (kg/m^2)	20.9±3.1	26.8±5.1	23.7±5.1	26.0±4.9	26.8±6.1	25.4±5.9	24.7±4.6	22.8±3.4	23.2±6.9
Waist to Hip Ratio, WHR	0.77±0.0	0.83±0.0	0.85±0.6	0.84±0.1	0.85±0.1	0.86±0.1	0.88±0.1	0.88±0.1	0.87±0.1
Grand Mean Thickness, GMT, (mm)	13.3±3.8	19.9±5.7	16.3±5.6	17.1±4.5	17.5±5.6	15.4±5.2	15.2±4.3	13.5±5.4	13.1±5.7

TABLE 4
RESPONSE OF DIFFERENT SITES TOWARDS ACCUMULATION OF BODY FAT (IN PERCENTAGE) AMONG ADULT FEMALES

Age Groups (years)	21–25	51–55	56–60	61–65	66–70	71–75	76–80	81–85	86+
Biceps SF	51	59.22	56.14	58.82	56.98	52.17	50.31	45.51	41.81
Sub-scapular SF	74.71	98.7	92.19	96.92	96.43	93.78	91.82	95.93	85.79
Supra-iliac SF	82.61	89.07	83.33	85.71	90.41	87.57	83.64	81.23	74.26
Calf lateral SF	95.54	79.92	80.37	85.71	82.74	83.85	90.56	88.93	103.1
Triceps SF	96.98	100.62	104.02	98.59	103.56	100	100	101.54	96.61
Calf medial SF	105.6	93.4	92.79	95.79	94.24	91.92	100.62	102.24	111.03
Calf posterior SF	110.63	97.74	99.29	95.79	96.43	98.75	106.28	105.74	113.91
Abdomen SF	120.69	135.29	137.11	132.21	132.05	134.78	131.44	128.15	128.33
Thigh SF	162.35	146.36	154.84	150.7	147.39	157.14	145.28	151.26	145.63

SF – skinfold thickness

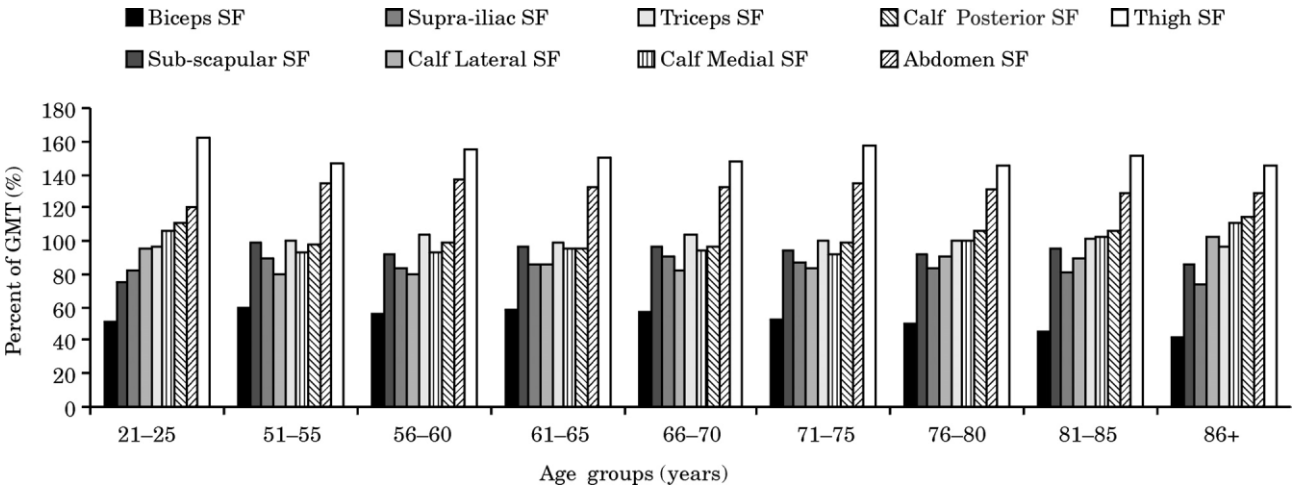

Fig. 2. Sensitivity of different skinfold (SF) thickness sites among adult females.

stature and sitting height showed a continuous decline after fifth decade of life. The decline in stature is a well-established fact and has been scientifically proved by many earlier workers[20–23]. This decline in stature is mainly due to decline in sitting height as the cartilage disc between vertebrae degenerates with the advancing age[24]. The long bones however, show very less changes with age.

Body weight showed an increase till 70 years of age followed by a decline. This increase in weight till sixth decade of life may be due to imbalance of energy in favour of energy intake. The grand mean thickness also showed a similar trend of increase and decline with age. Consequently increase in BMI till sixth decade of life in the present subjects is due to an increase in fat mass. The general tooth loss with age resulting in restricted food items in the diet of the elderly may be an important factor for reduced caloric intake and hence loss in body weight in more advanced age group. This result is consistent with findings of other scientist[25].

Researches have made it clear that it is not only the quantity of fat but the way it is distributed over the body has important health implications especially due to certain degenerative diseasesl[26, 27]. The age related decline in the subcutaneous fatness level in later years revealed by the skinfold thickness measurements at different sites of the body is supported by other authors also[22, 28–31]. More fat was stored on triceps and sub-scapular sites till 65 years of age followed by lesser fat at these sites in later years of age. More fat is found to be deposited on medial and posterior calf sites with a simultaneous loss of fat on lateral calf site in later years of age.

The body mass index and waist/hip ratio (WHR) are used as indices of obesity and fat distribution in epidemiological studies. Ratio of waist to hip circumference (WHR), introduced as a simple index of body fat distribution[29], differentiates the distribution of body fat in lower and upper body. According to WHR values, all the females of 51 years and above age groups showed upper body fat predominance. The lowest value of WHR, in young adult females indicated a more gynoid pattern of fat distribution as compared to rest of the females of 51 years and above. This shift from gynoid to android fat distribution with increasing age especially after menopause found in the present study was also reported by other workers[33].

Response or sensitivity of nine skinfold sites towards accumulation of fat, showed a differential rate of accumulation of fat at each site. Abdomen and subscapular sites were found to be the most sensitive sites towards fat deposition with age followed by calf, triceps, sub-scapular and supra-iliac sites.

The present study showed that the level of fatness expressed in whatever form increased with age till 6th decade of life and declined thereafter along with a redistribution of fat resulting in more android pattern of fatness. All the body girths, indices of body composition, profile of subcutaneous fat accumulation and sensitivity of each skinfold site showed an increasing fat deposition on trunk than on the appendages among test group females. The differential rate of fat accumulation at various sites in different age group females explains apparent differences in their physique and may have health consequences accordingly.

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SASTAV TIJELA I UZORAK RASPODJELE MASNOG TKIVA U GRADSKOJ POPULACIJI ŽENA STARIJE DOBI, DELHI, INDIJA

S A Ž E T A K

U ovom radu obuhvaćeno je 279 žena u dobi od 51–89 godina koje žive u gradskim naseljima Delhija u Indiji. Kontrolnu skupinu sačinjavale su mlade žene dobi od 21–25 godina. Prikupljeni su podaci za ukupno 14 antropometrijskih mjera: visina tijela, sjedeća visina, tjelesna masa, kožni nabori sa devet različitih mjesta na tijelu, opseg nadlaktice, opseg struka i opseg bokova. Sastav tijela je procijenjen korištenjem triju indeksa: indeks tjelesne mase (BMI), srednja vrijednost kožnih nabora te omjer opsega struka i bokova. Studija je provedena kako bi se ustanovila podložnost nakupljanju masti na različitim mjestima tijela koja je karakteristična za proces starenja. Pokazalo se da se sa starenjem mijenja regionalna raspodjela masnog tkiva. Naime, žene starije dobi (59–89) karakterizira veća količina masnog tkiva u gornjem dijelu tijela, dok je suprotan nalaz dobiven u kontrolnoj skupini mlađih žena. Ustanovljene su značajne razlike u sastavu tijela i profilu raspodjele masnog tkiva između ispitivane i kontrolne skupine žena. Pokazalo se da su abdomen i subskapularno područje mjesta najpodložnija nakupljanju masti s povećanjem dobi. Visina tijela i sjedeća visina pokazali su značajno smanjenje s godinama života. Svi pokazatelji debljine kao što su srednja debljina kožnih nabora, omjer opsega struk/bokovi te indeks tjelesne mase iskazali su značajne promjene u starijih žena što je pokazano usporedbom s kontrolnom skupinom mladih odraslih žena.