Volume 51(1):21-25, 2007
Acta Biologica Szegediensis
http://www.sci.u-szeged.hu/ABS

ARTICLE

Sensitivity of various skinfold sites to fat deposition in adolescent daughters and their mothers

Rashmi Sinha, Satwanti Kapoor*

Department of Anthropology, University of Delhi, Delhi, India

ABSTRACT The present study comprised of 412 adolescent daughters at a yearly intervals from age 11 through 17 years and their mothers who volunteered as subjects. All the subjects belonged to Punjabi speaking Khatri, an endogamous population residing in Delhi, India. A set of five skinfold thickness: biceps, triceps, subscapular, suprailiac and medial calf along with body weight and stature were taken on all the subjects to report the pattern of subcutaneous fat distribution and responsiveness of different skinfold sites to fat deposition with variation in total body fat content. An increase in body mass index (bmi) with age in the present sample with a concurrent increase in the grand mean thickness (GMT) is due to relative increase in fatness. All the skinfold thicknesses, indices of fatness, profile of subcutaneous fat accumulation and sensitivity of each skinfold site showed an increasing fat deposition on trunkal region than on extremities. It was noticed that subscapular site as the most sensitive site followed by triceps and biceps towards fat deposition. The differential rate of fat deposition at various sites in different age groups explains the difference in morphological feature in them.
Acta Biol Szeged 51(1):21-25 (2007)

KEY WORDS

adolescent daughters
fat distribution
mothers
sensitivity of skinfolds

Biological ageing is associated with the number of changes in body composition and body build. The etiology of these changes, all of which are not favorable was unclear up to now. With advancing age, fat free tissue weight decreases whereas fat tissue weight increases. Of the three large tissue components, bone, muscle and fat, the latter shows the greatest change during adulthood in both sexes. The body contours, which are determined by muscle and bone, and the thickness of overlying subcutaneous fat layer undergo a change with fluctuation in body weight. What is of utmost importance and has not gained much attention is the sensitivity of different skinfold sites towards fat accumulation with increase in fat content or with increasing age. Women continue with a largely unchanged fat patterning from puberty to middle age, but with advancing age not only body mass index increases, fat distribution pattern also changes.

The most obvious of the body contour fat patterning an integral aspect of human body has drawn considerable attention recently because of its association with several diseases (Jensen et al. 1989; Bjorntorp. 1990; Kanaley et al. 1993). The importance of the body fatness and its distribution lies in the epidemiological studies and as a clinical marker of health risk among populations. Fat distribution pattern has been extensively studied for decades (Garn 1954; Satwanti et al. 1980; Rimm et al. 1995; Joyce and Kapoor 1996; Sinha and Kapoor 2005), on ethnic variation in fat distribution (Satwanti et al. 1977; Stevens et al. 1992; Wardle et al. 1996) and on level of physical activity and fat distribution pattern (Brown and Jones 1977; Bhalla et al. 1983; Satwanti et al. 1984; Depress et al. 1985). It has become apparent that the fat distribution pattern is population, sex and age specific along with increase in obesity level. The pattern of fat distribution must be evaluated to assess the risk associated with weight gain, as the risk is higher if the fat distribution is already central (Lapidus et al. 1984; Ducimetiere et al. 1986; Kissebah et al. 1988).

The present study was undertaken to report the body mass index- an indicator of obesity and the sensitivity of different skinfold sites for fat deposition with varying body fat content among Indian adolescent girls and their mothers belonging to urban population.

Subjects and Methods

Four hundred and twelve Khatri adolescent girls residing in Delhi, India constituted the study. The girls at a yearly interval from age 11 through 17 years and their mothers 32-50 years volunteered as subjects in the present study. A set of five skinfold thicknesses (biceps, triceps, subscapular, suprailiac and medial calf) along with body weight and stature were taken on all the subjects in the present study. All the measurements were taken according to the techniques described by Weiner and Lourie (1981).

The profile of subcutaneous fat distribution over the body was obtained by arranging the skinfold site in ascending order of their thickness. An indicator of fatness - body mass

Accepted May 21, 2007
*Corresponding author. E-mail: satwanti@yahoo.com

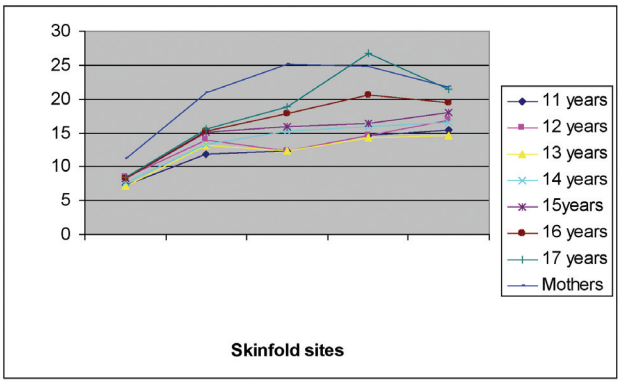

Figure 1. Distribution pattern of subcutaneous fat in adolescent girls and their mothers.

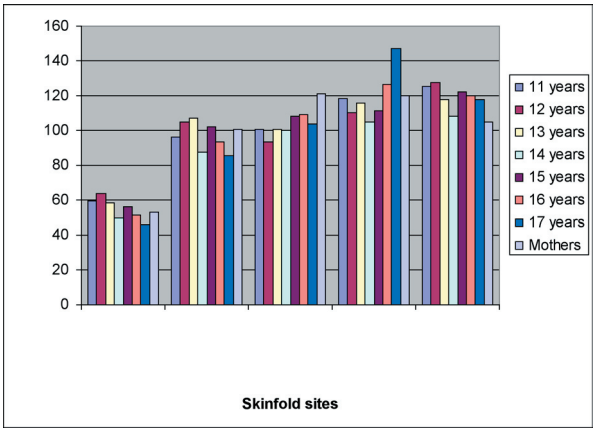

Figure 2. Response of different sites towards accumulation of body fat in adolescent daughters and their mothers.

index was calculated as weight in kg divided by stature in meter square. To study the rate of deposition or sensitivity of subcutaneous fat at different sites, each skinfold thickness was expressed as percent of grand mean thickness (GMT, *i.e.* mean thickness of skinfold at all the sites measured; Satwanti et al.1980). The data was analyzed using SPSS version 7.0.

Results

The means and standard deviations of body weight and stature including BMI for mothers and their daughters are given in Table 1. Skinfold thicknesses and GMT among adolescent daughters and their mothers are presented in Table 2. Table 3 shows the sensitivity of various skinfold sites to fat deposition in adolescent daughters and their mothers. The profile of subcutaneous fat distribution in adolescent girls and their mothers, determined by arranging various sites in ascending order of their thickness is illustrated in Figure 1 and Figure 2 shows the responsiveness of different skinfold site to fat deposition among adolescent daughters and their mothers.

Body weight showed a consistent increase with advancing age (from 11- 32-50 years) as it is evident from Table 1. After 14 years of age increase in body mass index is noticed with advancing age. Stature increased among growing girls with maximum increase in 12 year old subjects. Mothers were marginally shorter than their 17 – year – old daughters.

The distribution of fat pattern in adolescent daughters and their mothers (Table 2, Fig. 1) does not follow similar trend in all the age groups indicating on going tendency of fat redistribution with age, although in all the age groups biceps skinfold site shows the minimum fat, the site of maximum fat varies in different age groups. The distribution pattern of subcutaneous fat in different groups is as follows:

11 years Biceps < triceps < subscapular < suprailiac < medial calf

12 years Biceps < subscapular < triceps < suprailiac < medial calf

13 years Biceps < subscapular < triceps < suprailiac < medial calf

14 years Biceps < triceps < subscapular < suprailiac < medial calf

15 years Biceps < triceps < subscapular < suprailiac < medial calf

16 years Biceps < triceps < subscapular < medial calf < suprailiac

17 years Biceps < triceps < subscapular < medial calf < suprailiac.

Table 1. Basic data of the subjects.

Variable/Age		Adolescent girls (years)							Mothers (years)
		11 (n=54)	12 (n=60)	13 (n=60)	14 (n=62)	15 (n=51)	16 (n=64)	17 (n=61)	32-50 (n=108)
Weight (kg)	Mean	34.32	38.55	47.34	45.0	48.41	48.42	50.95	62.09
	±SD	7.00	8.34	7.40	7.73	5.84	5.11	7.11	12.17
Stature (cm)	Mean	135.8	148.68	151.23	153.57	155.34	155.45	155.80	153.63
	±SD	8.18	7.91	6.21	6.17	5.04	4.25	6.55	4.83
Body mass index (kg/m^2)		18.83	17.36	20.76	19.02	20.15	20.15	20.94	25.84

Table 2. Skinfold thickness and Grand mean thickeness of skinfolds of the subjects.

Skinfold thickness/ /Age		Adolescent girls (years)							Mothers ((years)
		11	12	13	14	15	16	17	35-55
Biceps(mm)	Mean	7.33	8.42	7.20	7.57	8.29	8.31	8.38	11.13
	±SD	3.39	2.69	3.71	2.87	2.92	1.71	2.22	5.51
Triceps(mm)	Mean	11.87	13.93	13.17	13.33	15.05	15.17	15.53	20.90
	±SD	3.85	4.99	4.11	4.80	4.68	4.17	4.57	6.92
Subscapular (mm)	Mean	12.37	12.38	12.37	15.19	15.95	17.76	18.88	25.16
	±SD	6.74	5.18	4.92	6.99	6.59	8.93	7.64	8.83
Suprailiac (mm)	Mean	14.58	14.64	14.26	15.94	16.44	20.58	26.79	24.87
	±SD	7.54	5.89	6.53	7.21	7.33	9.79	4.14	8.81
Medial calf(mm)	Mean	15.48	16.87	14.53	16.49	18.00	19.50	21.40	21.75
	±SD	6.96	6.43	6.92	7.20	6.82	8.09	7.38	8.59
Grand mean thickness(mm)		12.33	13.25	12.31	15.22	13.70	16.26	18.19	20.76

The pattern of subcutaneous fat distribution at 11, 14 and 15 years are same while that at 12 &13 years and 16 &17 years is distinctive of their age. Mothers' subcutaneous fat distribution pattern in ascending order is biceps, triceps, medial calf, suprailiac and subscapular. Both intra and inter group variation in the thickness of fatfold layer was thus depicted. A marked increase in total fat content as calculated by mean of the summing up of the five skinfold thickness (GMT) is found to increase with the advancing age.

The grand mean thickness (GMT) was found to be statistically significant between 13 & 14 years old girls and 17 year old daughters and mothers ($p< 0.05$). In rest of the age groups the difference were found to be statistically non-significant (Table 3).

To understand the reason for this phenomenon the sensitivity of different skinfold sites for accumulation of subcutaneous fat was assessed by expressing each site as percent of GMT (Fig. 2), thus ruling out any inter individual variations solely due to absolute fatness. Theoretically, any change in the GMT would be accompanied by change in the thickness of the skinfold at individual sites. The change thus occurring was not uniform at all sites as some sites gained relatively more fat as compared to others. It was noticed that subscapular site as the most sensitive site followed by triceps and biceps towards fat deposition.

Table 3. Significance of difference in the Grand mean thickness between different age groups.

Age groups (years)	value of 't' with level of significance
11&12	-.760
12&13	.817
13&14	2.35*
14&15	.348
15&16	-1.08
16&17	-1.56
17&,Mothers	-2.07*

*p<0.05

Discussion

There is a consistent increase in the body weight with advancing age from adolescence to middle aged mothers. The subcutaneous fat as assessed from skinfold thickness taken at various sites over the body and GMT (grand mean thickness) showed fluctuation in the study. The 17 year old daughters were found to be taller than their mothers reflecting the presence of secular trend due to improved nutritional status and living conditions of the population in the present study. There have been studies showing the increase in height and weight of people increasing with succeeding generations (Kapoor et al. 1984; Gordon-Larsen et al. 1997; Khanna and Kapoor 2004), a reflection of better nutrition, fewer diseases and better medical facilities (Tanner 1978). The Khatri daughters (17 year old) of the present sample were taller than their mothers. As mothers (mother vs. 17 year daughters) BMI were higher than of daughter, a major contribution in their weight gain could be attributed to gain in fatness, lending further support to "well founded concept of fat gain with ageing" (Nirmala and Reddy 1997; Tungdim et al. 2002). The higher value of GMT in mothers further supports this phenomenon.

The fluctuation in the skinfold thickness among girls could be a reflection of fluctuation for energy stores as fat is depleted in case of faster growth phase (Parizkova 1977; Kapoor et al. 1998; Sinha and Kapoor 2006). There are many changes during adolescence taking place; hence the body calls upon fat stores as and when required. Whereas continuously increasing body weight with age can be attributed to increase in muscle and skeletal mass which is at the cost of stored fat in the body. Juvenile obesity warrants early intervention because

the pattern of unhealthy behaviour is formed in adolescence and young adulthood (Riberio et al. 2004).

Adult fat distribution in females start manifesting itself from early pubertal period (Forbes 1990), supported by present study too. There is a relative loss of extremity fat from preadolescence through adulthood (Ramirez and Mueller 1980) as illustrated in the present study too. Skinfold thickness measurements in the study of Guilford et al. (2001) suggested a central pattern of body fat distribution. Young et al. (1962) claimed that at adolescence girls begin to assume fat distribution of a young woman with greater concentration on the lower trunk. The fat mass of body increases with age and also re-distribution of fat in body takes place in later age resulting in centripetal adiposity (Orden and Oyhenart 2006; Sinha and Kapoor 2006). The active role of children as social architects of their own biology should provide novel and important understanding of biocultural construction of childhood nutrition (Brewis and Gartin 2006).

The increase in BMI, an index of overweight/ obesity and a simultaneous increase in the GMT of skinfold thickness with age would entail this increase in weight due to increase in fatness. Higher values of all the five skinfold thickness of mothers as compared to the adolescent daughters in the present study also indicated an increase in fatness with age. All the skinfold thicknesses, indices of fatness, profile of subcutaneous fat accumulation and sensitivity of each skinfold site showed an increasing fat deposition on trunkal region than on extremities. The varying rate of fat deposition at various sites in different age groups explains the difference in morphological feature in them.

A consistent increase in fatness establishes the fact that fat content in females continously increase throughout life. This means reflection of increase in the measure of skinfold thickness at individual site. But this increase was not uniform at all the sites, as some sites seemed to gain proportionately more fat as compared to other sites with increase in the body fat. This phenomenon could be determinant of change in physique.

Sensitivity of the five skinfold site towards deposition of fat showed variation in different sites in different age groups. Subscapular was found to be most sensitive site towards fat deposition followed by triceps and biceps. This further strengthens the fact that even during the late adolescent period not only continues to increase in fat content but also favors redistribution of fat away from extremity towards the trunk and that adolescents (17 year old daughter) still does not have the same pattern of subcutaneous fat as the middle aged women (mothers).

In the present study all the fatness pointer/measure/indicator showed an increasing fat in favor of trunkal region. The differential rate of fat deposition at various sites in different age groups explains the difference in morphological feature in them and may have epidemiological significance.

Acknowledgements

We owe our sincere gratitude to Professor I.P. Singh for his unconditional and invaluable guidance. The financial assistance offered by Indian Council of Medical Research is gratefully acknowledged. The authors are thankful for cooperation extended by the subjects during data collection.

References

Bhalla R, Kapoor AK, Satwanti, Singh IP (1983) The distribution of subcutaneous fat with reference level of physical activity in adult females. Z Morph Anthropol 24:191-197.

Bjorntorp P (1990) The association between obesity, adipose tissue distribution and disease. Acta Med Scand 723:121-134.

Brewis A, Gartin M (2006) Biocultural construction of obesogenic ecologies of childhood:Parent feeding versus child eating strtigies. Am J Hum Biol 18:203-213.

Brown WJ, Jones PRM (1977) The distribution of body fat in relation to habitual activity. Ann Hum Biol 4:537-550.

Depress JP, Bouchard C, Trembley A, Savard R, Marcotte M (1985) Effect of aerobic training on fat distribution in male subjects. Med Sc Sports Exerc 17:113-118.

Ducimetiere P, Richard J, Cambien F (1986) The pattern of subcutaneous fat distribution in middle aged man and the risk of coronary heart disease: The Paris prospective study. Int J Obes 10:229-240.

Forbes GB (1990) The abdomen: Hip ratio normative data and observation on selected patients. Int J Obes 14:149-157.

Garn SM (1954) Fat patterning and fat intercorrelation in adult males. Hum Biol 26:59-69.

Godon-Larsen P, Zemel BS, Johnston FE (1997) Secular change in stature, weight, fatness,overweight and obesity in urban African American adolescents from mid 1950's to mid 1990's. Am J Hum Biol 9:675-688.

Guilford MC, Mahabir D, Rocke B, Chinn S, Rona R (2001) Overweight, obesity and skinfold thicknesses of children of African or Indian descent in Trinidad and Tobago. Int J Epidemiol 30:989-998.

Jensen MD, Haymond MW, Rizza RA, Cryer PE, Miles JM (1989) Influence of body fat distribution on free fatty acid metabolism in obesity. J Clin Invest 83:1168-1173.

Joyce KP, Kapoor S (1996) Pattern of subcutaneous fat distribution, its variation with age among young Rajput females of Pauri Garhwal, India. J Hum Ecol 7:45-49.

Kanaley JA, Andersen–Reid ML, Oenning LV, Kottke BA, Jensen MD (1993) Differential health benefits of weight loss in upper –body and lower body obese. Amer J Clin Nutr 57:20-26.

Kapoor S, Kapoor AK, Kumbnani HK, Bhalla R (1984) Anthropometry of newborns: change over a decade. Acta Med Auxol 16:223-226.

Kapoor S, Patra PK, Sandhu S, Kapoor AK (1998) Fatness and its distribution pattern among Jat Sikhs. J Ind Anthrop Soc 33:223-228.

Khanna G, Kapoor S (2004) Secular trend in stature and age at menarche among Punjabi Aroras residing in New Delhi, India. Coll Anthropol 28:571-575.

Kissebah AH, Peiris A, Evans DJ (1988) Mechanisms associating body fat distribution to glucose intolerance and diabetes mellitus.. In: Bouchard C, Johnston FE, Alan R (Eds): Fat Distribution during Growth and later Health Outcomes. Liss. New York. pp. 203-220.

Lapidus L, Bengtsson C, Larsson B, Pennert K, Rybo E, Sjostrom L (1984) Distribution of adipose tissue and risk of cardiovascular disease and death: A 12-y follow up of participants in the population study of women in Gothenberg, Sweden. Brit Med J 289:1257-1260.

Nirmala A, Reddy PC (1997) A study of blood pressure on the aged. In: Life in Twilight Years. Quality Book Company Publishers, Calcutta, India. p. 223-228.

Orden AB, Oyhenart EE (2006) Prevalence of overweight and obesity among Gurani-Mbya from Misiones,Argentina. Am J Hum Biol 18:590-599.

Parizkova J (1977) Body fat and physical fitness. The Hague, Martinus Nijhiff, B. V. Med. Div. 1

Ramirez ME, Mueller WH (1980) The development of density and fat patterning in Tokelau Children. Hum Biol 52:675-687.

Riberio JC, Gurra S, Oliveira J, Anderson LB, Dyarte JA, Mota J (2004) Body fatness and clustering of cardiovascular disease risk factors in Portuguese children and adolescents.Am J Hum Biol 16:556-562.

Rimm EB, Stampfer MJ, Giovannucci E, Ascherio A, Spiegelman D, Golditz GA, Willet WC (1995) Body size and fat distribution as predictors of coronary heart disease among middle –aged and older US men. Am J Epidemiol 141:117-1127.

Satwanti, Bharadwaj H, Singh IP (1977) Relationship of body density to body measurements in young Punjabi women: Applicability of body composition prediction equations developed for women of European descent. Hum Biol 49:203-213.

Satwanti, Singh IP, Bharadwaj H (1980) Fat distribution in lean and obese young Indian women: A densitometric and anthropometric evaluation. AJPA 53:611-616.

Satwanti, Kapoor AK, Bhalla R, Singh IP (1984) A study of the distribution pattern of fat in male gymnasts. Anthrop Anz 42:131-136.

Sinha R, Kapoor S (2005) Fat patterning among Indian adolescent Boys and Girls. Ind J Phy Anthrop Hum Genet 24:135-141.

Sinha R, Kapoor S (2006) Parent-Child Correlation for Various Indices of Adiposity in an Endogamous Indian Population. Coll Antrop 30:291-296.

Stevens J, Keil JE, Rust PF, Tyroler HA, Davis CE, Gazes PC (1992) Body Mass Index and body girths as predictors of mortality in black and white women. Arch Intern Med 152:1257-1262.

Tanner JM (1978) Foetus into man: physical growth from conception to maturity. London: Open Books.

Tungdim MG, Kapoor S, Kapoor AK (2002) Morpho-physiological changes among high altitude aged. Ind J Med Res 16:329-343.

Ulijaszek SJ, Strickland SS (1996) Body Mass Index and fat patterning of adults in rural Sarawak. Mal J Nutr 2:128-136.

Wardle J, Wrightson K, Gibson L (1996) Body fat distribution in South Asian Children. Int J Obes 20:267-271.

Weiner JS, Lourie JA (1981) Human Biology. A guide to field methods. IBP Handbook no 9. Oxford Blackwell Sci Publication.

Young CM, Martin MEK, Tensuan RS, Blondin J (1962) Predicting specific gravity and body fatness in young women. J Am Diet Assoc 40:102-107.

Young CM, Martin MEK, Tensuan RS, Blondin J (1962) Predicting specific gravity and body fartness in young women. J Am Diet Asso 40:102-107.