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Body Fat Compositon and its Relationship with Subcutaneous Adiposity in Adult Caucasion and Migrant Pakistani Men Resident in Peterborough, England

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ABSTRACT A cross-sectional study of 262 abult indigenous Caucasian and 100 migrant Pakistani men residing in Peterborough, England, found significant ethnic differences (age corrected) in regional subcutaneous adiposity but no significant differences in body mass index (BMI), per cent body fat (PBF), fat mass (FM) and fat mass index (FMI). Age, BMI and all measures of subcutaneous adiposity (skinfolds) had similar associations with PBF, FM and FMI in both ethnic groups. However, ethnicity was found to have significant ($p < 0.0001$) associations; independent of age, BMI, PBF, FM and FMI; with abdomen, chest, forearm, midaxillary, subscapular and suprailiac skinfolds. Migrant Pakistanis had significantly ($p < 0.001$) greater mean abdomen (+6.6 mm), chest (+3.5 mm), midaxillary (+5.0 mm), subscapular (+7.4 mm) and suprailiac (+6.1 mm) skinfolds; they also had significantly lower mean forearm (-1.2 mm) skinfold; even after removing the combined effects of age, BMI, PBF, FM and FMI. This significant ethnic difference in subcantaneous adiposity could have health implications.

INTRODUCTION

Only a few investigations (Miller et al., 1988; Bose, 1995) have studied subcutaneous adiposity among migrant South Asian in Britain. A recent study in Britain (Bose, 1995) has shown that adult migrant Pakistani men have distinctly different pattern of regional subcutaneous adiposity compared with Caucasian men. It has been suggested (McKeigue et al., 1991) that ethnic difference in central adiposity may be the cause of South Asians having significantly higher prevalence of coronary heart disease (CHD) and non-insulin dependent diabetes mellitus (NIDDM) compared with Caucasians. However, to date, information on common indicators of body fat composition like per cent body fat (PBF), fat mass (FM) and fat mass inded (FMI), and their association with regional subcutaneous adiposity in South Asian populations is lacking.

The present study was undertaken to determine the relationship of three indicators of body fat composition, namely PBF, FM and FMI with age, BMI, and various measures of regional subcutaneous adiposity in adult Caucasian and migrant Pakistani men. It also investigated whether any ethnic difference in regional subcutaneous adiposity could be explained by these indicators of body fat composition.

MATERIAL AND METHODS

Outline of Fieldwork

This study was conducted at three inner city General Practices in Peterborough, England. Complete lists (containing information on name, address and date of birth) of all adult male patients registered at these practics were provided. Pakistanis were identified on the basis of surnames. This method is widely recognised as a convenient and efficient way to assess ethnicityin the absence of any specific information on ethnic origin (Balarajan et al., 1984; Nicoll et al., 1986). Two ethnic groups (Caucasians and Pakistanis) were studied and classification of ethnicity was based on the Office of Population Censuses and Surveys Census H Form (OPCS, 1991).

Invitation and Participation of Subjects

Letters along with a questionnaire were sent to all adult (> 19 year of age) Pakistani men and randomly selected adult Caucasian men. A total of 362 subjects (262 indigenous Caucasian and 100 Pakistanis) were studied. The Pakistani men studied in this investigation originated from the

Mirupur area of Kashmir, North-Eastern Pakistan. They migrated to Britain as a result of a large rural population being displaced by a dam built in the 1960s (Ballard, 1988).

Anthropometric Measurements

All anthropometric measurements were made by one investigator (KB) using the standard techniques recommended by Lohman et al. (1988). A total of nine skinfolds (abdomen, anterior thigh, chest, forearm, medial calf, midaxillary, subscapular, suprailiac and triceps) were measured to study regional subcutaneous adiposity. Skinfolds were measured on the right side of the body and the reading recorded in millimetres.

Percentage Body Fat, Fat Mass and Fat Mass Index

Three measures of body fat composition, namely percentage body fat (PBF), fat mass (FM) and fat mass index (FMI) were studied. Estimate of PBF was made from the triceps skinfold measurement using the equation derived for British subjects by Durnin and Womersley (1974). FM was then calculated.

The following equations were used:

percentage body fat = (4.95/density - 4.5) 100
where
density = 1.1143 - (0.0618 log 10 triceps).
FM (kg) = percentage body fat/100 × weight (kg)

FMI (fat mass normalised for height was calculated according to Vanltallie et al. (1990).

FMI = Fat Mass in kg / height in M^2

Statistical Analyses

Statistical analyses were performed using the Statistical Package for Social Science (SPSS/PC+ Version 5) on a IBM-compatible personal computer. The distributions of BMI, and anterior thigh, forearm, medial calf and triceps skinfolds were log transformed to normalise the data. Log transformed values were used in correlation and multiple regression analyses. Students' t-test was used to test for difference in age between the two ethnic groups. Multiple regression analyses were used to determine ethnic differences (age controlled) in the anthropometric and bodyfat composition variables, as well as the effect of age and ethnicity on BMI, FM and FMI. Ethnic heterogeneity in the associations of age, BMI and eight skinfolds with PBF, FM and FMI were determined following the methods described by Sokal and Rohlf (1986). The effect of ethnicity on the skinfolds, after controlling for age, BMI, PBF, FM and FMI, was studied using multiple regression analyses. Multiple regression analyses were also performed to test for heterogeneity and difference in mean skinfolds between the ethnic groups, after removing the effect of age, BMI, PBF, FM and FMI.

RESULTS

On average, Caucasian men (mean = 51.8, s.d. = 15.6 years) were significantly ($p < 0.001$) older than Pakistani men (mean = 41.2, s.d. = 14.5 years). However, the minimum (Caucasians = 21.5; Pakistanis = 19.7 years) and maximum (C = 81.2; P = 81.8 years) ages were similar in both ethnic groups. Thus, the age ranges (C = 59.7, P = 62.1 years) were similar in the two groups. Table 1 presents the anthropometric and body fat composition characteristics of Caucasian and migrant Pakistani men. There was no significant ethnic difference in mean BMI, PBF, FM and FMI. However, migrant Pakistanis had significantly ($p < 0.0001$) higher mean abdomen (P = 36.8; C = 33.0), chest (P = 23.7; C = 22.9), midaxillary (P = 26.6; C = 24.5), subscapular (P = 29.9; C = 24.8) and suprailiac (P = 29.9; C = 24.9) skinfolds; and significantly lower mean forearm skinfold (P = 5.3; C = 6.2) compared with Caucasians, after age correlation. Age ($p < 0.001$) and ethnicity ($p < 0.05$) had significant effect on BMI but not on PBF, FM and FMI. However, the association of ethnicity with BMI, after removing the effect of age, was not significant.

Table 2 presents the correlation coefficients of age, BMI and eight skinfolds (excluding triceps) with PBF, FM and FMI. BMI and all eight skinfolds had strong correlations with PBF, FM and FMI in both ethnic groups, with no significant ethnic heterogeneity existing between the groups in any of the relationships.

Table 3 presents the significant ethnicity influence on the skinfolds, after controlling for the combined effects of age, BMI, PBF, FM and

Table 1: Anthropometric and body fat composition characteristics of adult Caucasian and migrant Pakistani men

Variable	*Caucasians (n = 262) Mean*	*Pakistani (n = 100) Mean*	*Age Controlled Ethnic Difference*
Body Mass Index (kg/m^2)	25.9 (3.4)	25.2 (4.1)	n.s.
Skinfolds (mm)			
Abdomen*	33.0 (9.0)	36.8 (9.7)	P > C
Chest***	22.9 (7.6)	23.7 (8.8)	P > C
Midaxillary**	24.5 (7.5)	26.6 (9.4)	P > C
Subscapular*	24.8 (8.3)	29.9 (9.8)	P > C
Suprailiac*	24.9 (7.0)	29.9 (8.9)	P > C
Anterior thigh	20.3 (6.7)	20.0 (6.2)	n.s.
Forearm*	6.2 (1.9)	5.3 (1.3)	C > P
Medial calf	14.1 (6.0)	13.2 (5.6)	n.s.
Triceps	15.3 (5.5)	15.3 (5.7)	n.s.
Body Composition			
Percent Body Fat	24.7 (4.4)	24.6 (4.7)	n.s.
Fat Mass (kg)	19.8 (5.7)	18.9 (6.4)	n.s.
Fat Mass Index (kg/m^2)	6.5 (1.8)	6.3 (2.0)	n.s.

Figures in parentheses indicate standard deviation
* $P < 0.0001$
** $P < 0.0005$
*** $P < 0.0025$
P > C Pakistanis have significantly higher mean compared with Caucasians
C > P Caucasians have significantly higher mean compared with Pakistanis
n.s. Not significant

FMI. Ethnicity was obsered to have significant ($p < 0.0001$) associations with abdomen, chest, midaxillary, subscapular, suprailiac and forearm skinfolds, even after removing the effects of age, BMI and the three measures of body fat composition. Subsequent multiple regression analysis revealed that (Table 4) migrant Pakistani men had significantly higher mean abdomen (+6.6 mm), chest (+3.5 mm), midaxillary (+5.0 mm), subscapular (+7.4 mm) and suprailiac (+6.1 mm) skinfolds; they also had significantly ($p < 0.0001$) lower mean forearm skinfold (-1.2 mm), even after controlling for these effects.

Table 2: Correlations of age, BMI and skinfolds with PBF, FM and FMI in the two ethnic groups

Correlates	*Caucasians (n = 262) r*	*Pakistanis (n = 100) r*
Age		
with		
PBF	-0.016^	0.099^
FM	-0.028^	0.100^
FMI	0.059^	0.112^
BMI		
with		
PBF	0.543*	0.723*
FM	0.777*	0.860*
FMI	0.838*	0.903*
Abdomen Skinfold		
with		
PBF	0.556*	0.708*
FM	0.665*	0.739*
FMI	0.656*	0.771*
Chest Skinfold		
with		
PBF	0.606*	0.754*
FM	0.682*	0.803*
FMI	0.712*	0.824*
Midaxillary Skinfold		
with		
PBF	0.585*	0.714*
FM	0.689*	0.786*
FMI	0.714*	0.808*
Subscapular Skinfold		
with		
PBF	0.619*	0.762*
FM	0.753*	0.807*
FMI	0.776*	0.853*
Suprailiac Skinfold		
with		
PBF	0.609*	0.714*
FM	0.709*	0.777*
FMI	0.703*	0.793*
Anterior Thigh Skinfold		
with		
PBF	0.685*	0.718*
FM	0.693*	0.745*
FMI	0.690*	0.758*
Forearm Skinfold		
with		
PBF	0.480*	0.539*
FM	0.453*	0.604*
FMI	0.441*	0.621*
Medial Calf Skinfold		
with		
PBF	0.660*	0.776*
FM	0.649*	0.785*
FMI	0.665*	0.781*

* $p < 0.001$.
^ Not significant.
r Correlation coefficient.
No significant ethnic heterogeneity in correlation coefficients between the two groups

Table 3: Multiple regression analyses of ethnicity on skinfolds after controlling for age, BMI, PBF, FM and FMI

	Effect of ethnicity (after controlling for Age, BMI, Percent Body Fat, Fat Mass and Fat Mass Index) on Skinfolds			
Skinfold	*B*	*SEB*	*Beta*	*T*
Abdomen	6.638	0.762	0.318	8.710*
Chest	3.562	0.577	0.199	6.113*
Midaxillary	4.987	0.578	0.275	8.625*
Subscapular	7.395	0.601	0.348	12.302*
Suprailiac	6.132	0.618	0.348	9.916*
Forearm	-1.159	0.012	-0.245	-5.160*

* $p < 0.0001$ (Sig. T).

Table 4: Ethnic differences in mean skinfolds after controlling for age, BMI, PBF, FM and FMI

Skinfold	*Mean (mm)*	*SE Mean (mm)*	*Ethnic difference between Caucasians and Pakistanis*
Abdomen	+6.6	0.8	P > C
Chest	+3.5	0.6	P > C
Midaxillary	+5.0	0.6	P > C
Subscapular	+7.4	0.6	P > C
Suprailiac	+6.1	0.6	P > C
Forearm*	-1.2	1.0	C > P

* Geometric mean and SE mean are presented. Caucasians have been set ot zero

P < 0.001 (Sig. F Change) in all cases

P > C Pakistanis have significantly greater mean than Caucasians

C > P Caucasians have significantly greater mean than Pakistani

DISCUSSION

As early as 1956 (Vague, 1956) it was observed that excess body fat around the abdomen, although more common among males, was related to diabetes and atherosclerosis in both males and females. This observation has been supported by much clinical, physiological and epidemiological work (Kissebah et al., 1989). Despite these advances, large scale studies on fat distribution and the risk of chronic disease have been hampered by the fact that the most accurate technique for assessing abdominal fat mass, axial computerized tomography (ACT), is costly and time-consuming (Valdez et al., 1993). Anthropometry could be a valid alternative to ACT in population studies on fat distribution. However, current anthropometric indicators of obesity have several limitations. The BMI is not sensitive to body fat distribution (Keys et al., 1972; Garn et al., 1986; Forbes, 1990) and the waist-to-hip ratio (WHR), although somewhat sensitive to fat distribution, does not have standard values that allow inter-individual or inter-pupulation comaprisons (Hartz et al., 1984).

Significant ethnic differences in regional subcutaneous adiposity (Bose, 1995) between adult Caucasian and migrant Pakistani men in Britain have been reported before. However, to date, body fat composition and its influence on regional subcutaneous adiposity in migrant South Asians has not been studied. The present study was undertaken to determine whether various measures of body fat composition could account for the significant ethnic heterogeneity in regional subcutaneous adiposity which exists between these two groups.

The results fo this investigation unequivocally demonstrated that there existed significant ethnic difference (age corrected) in regional subcutaneous adiposity, between Caucasian and migrant Pakistani men. The three body fat composition measures, namely, PBF, FM and FMI, which were computed using standard equations for adult Caucasian males (Durnin and Womersley, 1974; VanItallie et al., 1990) were also found to be appropriate for use in the migrant Pakistani men. Since there was no significant ethnic heterogeneity in the correlations of these measures with BMI and the skinfolds, these equations are not 'ethnic-specific' to Caucasians and can be used to determine PBF, FM and FMI in other ethnic groups like South Asians.

The significant ethnic differences in regional subcutaneous remained even after controlling for the combined effects of age, BMI, PBF, FM and FMI. The conclusion from these observations is that these ethnic differences between adult Caucasian and migrant Pakistani men are not explained by age, BMI and body fat composition variables like PBF, FM and FMI but is due to other factors. Since regional adiposity is influenced by both, environmental as well as genetic determinants (Bouchard, 1990), future studies on migrant South Asians should lay more emphasis on the genetic basis of regional adiposity and bodyfat composition. At present, information on genetic component as a determinant of regional adiposity and body fat

composition in migrant South Asian groups is lacking. It is possible, that genetic influence is primarily responsible for the ethnic heterogeneity in regional subcutaneous adiposity between Caucasians and South Asians and that body fat composition plays a minor or insignificant role. Thus, inter-generational studies is of particular importance in understanding the genetic basis of the ethnic difference in regional adiposity between Caucasians and migrant South Asians.

This significant ethnic difference in regional subcutaneous adiposity between adult Caucasian and migrant Pakistani men, which is independent of age, BMI, PBF, FM and FMI, could have health implications, particularly with relation to the excess prevalence of coronary heart disease (CHD) and non-insulin dependent diabetes mellitus (NIDDM) observed in South Asian communities in Britain.

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