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Relationship of Age and the Body Mass Index with Subcutaneous Adiposity in Adult European and Migrant South Asian Males Resident in Peterborough, England

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KEY WORDS Age. Body Mass Index. Skinfold. Ethnicity. Europeans. Indians. Pakistanis.

SUMMARY A comparative study of the interrelationships of age and the body mass index (BMI) with subcutaneous adiposity (measured by skinfolds) in adult White European (n = 262) and migrant Indian (n = 39) and Pakistani (n = 100) males residing in Peterborough, East Anglia, revealed significant ethnic differences in mean skinfolds between Europeans and Indians/Pakistanis (South Asians). Age and similar association with all the skinfolds in the three ethnic groups. Multiple regression analyses revealed that for any given age, South Asians have significantly higher mean subscapular, suprailiac, abdomen, chest and midaxillary skinfold but significantly lower mean forearm skinfold compared to Europeans. These significant ethnic differences remained even after controlling for the effect of the BMI.

INTRODUCTION

Skinfolds have become a popular tool for assessing fat patterns and fat distribution in population and epidemiological studies. However, there seems to be little agreement as to which measurements may be optimal indicators of fat distribution in relation to risks of non-insulin dependent diabetes mellitus and coronary heart disease. Seidell et al. (1992) have proposed that subcutaneous fat patterning assessed by skinfolds is measuring different aspects of fat distribution compared to circumferences and circumference ratios. Studies (Seidell et al., 1987) have demonstrated that amounts of intra-abdominal and subcutaneous fat can be predicted accurately by means of easy-to-measure anthropometric variables and age. These predictions may be important in future research because they enable the specific effects of these fat depots on morbidity and mortality to be estimated.

Subcutaneous body fat distribution has been measured by skinfolds in many studies (Norgan and Ferro-Luzzi, 1986; Reichley et al., 1987 ; Blair et al., 1988). Recent studies of body fat distribution in the Netherlands (Seidell et al., 1987), Mexican Americans (Mueller et al., 1991), Europeans (Seidell et al., 1992), and Hispanic and non-Hispanic Americans (Sosenko et al., 1993), have utilised various skinfold measures and indices. The use of skinfolds to study body fat distribution in non-obese individuals is important in understanding anthropometric distribution of subcutaneous adiposity (Mueller et al., 1991).

Although recent studies in Britain (Miller et al., 1988; McKeigue et al., 1991; Bose, 1995; Bose and Mascie-Taylor, 1995 have reported skinfold measurements in South Asians, no investigation, to date, has studied in detail the interrelationships of age and the BMI with subcutaneous adiposity in South Asians. The present study investigated the interrelationships of age with subcutaneous adiposity (measured by skinfolds) in native European and migrant South Asian (Indian and Pakistani origin) men resident in Peterborough (East Anglia), England. It also studied whether significant ethnic differences in subcutaneous adiposity existed after controlling for the linear and quadratic effects of age and the BMI.

MATERIAL AND METHODS

Details of the sampling method and response rate of this study have already been reported elsewhere (Bose and Mascie-Taylor, 1997). It is sufficient to note here that 262 European, 39 Indian and 100 Pakistani adult men (age > 19 yrs). resident in Peterborough, East Anglia were studied. All anthropometric measurements were made by one trained investigator (KB) using standard techniques recommended by Lohman et al. (1988). A total of five truncal (subscapular, suprailiac, abdomen, chest, midaxillary) and four extremity (forearm, triceps, anterior thigh, medial calf) skinfolds were measured.

The distributions of the BMI, and forearm, triceps, anterior thigh , medial calf and sum of all skinfolds were normalised using a logarithmic (base 10) transformation. Transformed values were used in all statistical analyses. Testing for heterogeneity of the correlation coefficients were undertaken following the method described is Sokal and Rohlf (1986).

RESULTS

Age Differences

A one-way analysis of variance showed significant heterogeneity in the mean ages between the three groups ($F = 17.93$, $p < 0.0001$), and the Scheffe a posteriori test (2,398) demonstrated that Europeans (51.8 ± 15.6 yrs) were significantly older than Pakistanis (41.2 ± 14.5 yrs) but not Indians (45.4 ± 127.5 yrs). The minimum and maximum ages, however, were similar in all the groups. Thus, the age ranges were similar in the three groups.

Anthropometric Variation Between the Three Ethnic Groups

Table 1 presents the means and standard deviations of anthropometric variables in the three ethnic groups. Differences among mean values were examined using multiple regression analysis, and after removing the linear and quadratic effects of age the means of Indian, Pakistani, and Europeans (whose means were set to zero) were compared (Table 2). Significant differences in subcutaneous adiposity were observed between South Asians and Europeans. South Asians had significantly higher mean subscapular ($p < 0.0001$), suprailiac ($p < 0.0001$), abdomen ($p > 0.0001$), chest ($p < 0.0025$), midaxillary ($p < 0.0005$) and sum of all skinfolds ($p < 0.005$) but significantly lower ($p < 0.0001$) mean forearm skinfold. The significant differences remained (Table 3) after the BMI was included in the model.

Table 1: Means and standard deviations of anthropometic variables in the three ethnic groups

Variable (unit)	*Europeans (n = 262)*		*Indians (n = 39)*		*Pakistanis (n = 100)*	
	Mean	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D*
Height (cm)	174.6	6.7	170.1	11.0	172.2	6.4
Weight (kg)*	78.2	1.2	69.2	1.2	73.6	1.2
Body mass * index (kg/m²)	25.7	1.2	24.0	1.2	25.1	1.2
Skinfolds (mm)						
Truncal						
Subscapular	24.8	8.3	28.8	7.8	29.9	9.8
Suprailiac	24.9	7.0	29.6	7.1	29.9	8.9
Abdomen	33.0	9.0	35.9	8.8	36.8	9.7
Chest	22.9	7.6	24.8	7.9	23.7	8.8
Midaxillary	24.4	7.5	25.1	7.3	26.6	9.4
Extremity						
Forearm*	6.0	1.3	5.2	1.3	5.1	1.3
Triceps*	14.5	1.4	13.2	1.4	14.5	1.5
Anterior thigh*	19.1	1.4	19.5	1.3	19.1	1.4
Medial calf*	12.9	1.5	12.6	1.5	12.0	1.5
Sum of all* skinfolds	179.1	1.3	191.4	1.3	191.0	1.4

*Geometric means and standard deviations are presented

Table 2: Differences in the mean values of anthropometric variables between the three ethnic groups (Europeans set to zero) after controlling for the linear and quadratic effects of age

Variable	*Indians (n = 39)*		*Pakistanis (n = 100)*		
Variable (unit)	*Mean Before*	*Mean After*	*Mean before*	*Mean After*	*Significance of F change*
Height (cm)	- 4.5	- 4.9	- 2.4	- 3.3	p < 0.0001
Weight (kg)*	-9.0	- 1.0	- 4.6	- 1.1	p < 0.0001
Body mass* index (kg/m²)	- 1.7	- 1.1	- 0.6	- 1.0	n.s.
Skinfolds (mm)					
Truncal					
Subscapular	4.4	5.1	5.1	6.6	p < 0.0001
Suprailiac	4.7	5.0	5.0	5.2	p < 0.0001
Abdomen	2.9	4.2	3.8	5.3	p < 0.0001
Chest	1.9	3.3	0.8	2.7	p > 0.0025
Midaxillary	0.7	2.0	2.2	3.9	p < 0.0005
Extremity					
Forearm*	- 0.8	- 1.2	- 0.9	- 1.2	p < 0.0001
Triceps*	- 1.3	- 1.1	0.0	- 1.0	n.s.
Anterior thigh*	0.4	- 1.0	0.0	- 1.0	n.s.
Medial calf*	- 0.3	- 1.0	-.0.9	- 1.1	n.s.
Sum of all* skinfolds	12.3	1.1	11.9	1.1	P<0.005

n.s. not significant.
* Geometric means and standard deviations are presented.

Table 3 : Differences in the mean values of skinfolds between the three ethnic groups (Europeans set to zero) after controlling for the linear and quadratic effects of age and the body mass index

	Indians		*Pakinstanis*		*Significance*
Skinfolds	*Mean*	*S.E.*	*Mean*	*S.E.*	*of F change*
Truncal					
Subscapular	7.548	0.919	7.288	0.647	$p < 0.0001$
Suprailiac	6.914	0.959	5.778	0.675	$p < 0.0001$
Abdomen	6.406	1.151	5.916	0.809	$p < 0.0001$
Chest	5.295	0.912	3.304	0.641	$p < 0.0001$
Midaxillary	4.157	0.872	4.527	0.613	$p < 0.0001$
Extremity					
Forearm*	- 1.107	1.043	1.159	1.030	$p < 0.0001$
Triceps*	1.003	1.054	1.024	1.037	n.s.
Anterior thigh*	1.073	1.047	- 1.004	1.033	n.s.
Medial calf*	1.050	1.063	- 1.057	1.044	n.s.
Sum of all*	1.206	1.033	1.142	1.023	$p < 0.0001$

The unit for all skinfolds is mms
n.s. not significant
*Geometric means andstandard errors are presented

The relationship between age with skinfolds was investigated in the three groups. Although significant correlations existed with some skinfolds, there was no significant ethnic heterogeneity (Table 4). There was also no significant heterogeneity between the ethnic groups for the partial correlations which took into account the linear and quadratic effects of age (results not shown). The absence of significant heterogeneity between partial correlations could indicate either complete overlap of distributions in the three ethnic, or a parallel response, *i.e.*, with

Table 4: Correlation Coefficients of age with skinfolds in the three ethnic groups

Skinfold	*Europeans (n = 262)*	*Indians (n = 39)*	*Pakistanis (n = 100)*
Subscapular	0.219[4]	0.221	0.286[3]
Suprailiac	- 0.022	0.141	0.093
Abdomen	0.134[1]	0.391[2]	0.407[4]
Chest	0.329[4]	0.477[3]	0.384[4]
Midaxillary	0.307[4]	0.392[2]	0.323[3]
Forearm	- 0.042	0.146	0.020
Triceps	0.015	0.115	0.098
Anterior thigh	- 0.130[1]	0.131	0.016
Medial calf	- 0.082	0.159	- 0.017
Sum of all	0.151[2]	0.345[1]	0.286[3]

No significant ethnic heterogeneity in correlation coefficients
1. $p < 0.05$
2. $P < 0.025$
3. $p < 0.005$
4. $p < 0.001$

significant heterogeneity between the regression coefficients (b values). Multiple regression revealed that for subscapular ($p < 0.0001$), suprailiac ($p < 0.0001$), abdomen ($p < 0.0001$), chest ($p < 0.0025$), midaxillary ($p < 0.0005$), forearm ($p < 0.0001$) and sum of all skinfolds ($p > 0.005$), significant ethnic differences existed (Table 5). Thus, SouthAsian men tend to have significantly higher mean subscapular, suprailiac, abdomen, chest and sum of all skinfolds than European men (Table 5) at any given age, while European mean have significantly higher mean forearm skinfold than Indian and Pakistani men. In the case of midaxillary skinfold, Pakistanis have significantly higher mean (Indians also have higher but not significant) compared with Europeans at any given age.

When the BMI was included in the model, results (Table 6) revealed that the significant ethnic differences in the regression coefficients (b values) remained. Thus, for any given age and BMI, South Asian men tend to have significantly higher mean subscapular ($p < 0.0001$), suprailiac ($p > 0.0001$), abdomen ($p < 0.0001$,chest ($p < 0.0001$), midaxillary ($p < 0.0001$) and sum of all skinfolds ($p < 0.0001$) than European men (Table 6), while European men have significantly higher ($p < 0.0001$) mean forearm skinfold than Indian and Pakistani men.

DISCUSSION

Although recent studies in Britain (Miller et al., 1988; McKeigue et al., 1991; Bose, 1995, Bose and Mascie-Taylor, 1995) have reported ethnic differences in skinfold measurements between adult European and South Asian men, no investigation has studied, in detail, the interrelationships of age and the BMI with subcutaneous adiposity in South Asians.

In the present study, no significant ethnic heterogeneity was observed in the relationships of age and age^2 with the skinfolds. Multiple regression analysis demonstrated that the distributions of triceps, anterior thigh and medial calf skinfolds in the three ethnic groups were similar. However, there was significant heterogeneity in b values between Europeans and South Asians for subscapular, suprailiac, abdomen, chest midaxillary, forearm and sum of all skinfolds.

Table 5 : Ethnic differences in skinfolds (Europeans set to zero) after controlling for the linear and quadratic effects of age

Skinfold	*Sig. F change*	*Indians (n = 39)*		*Pakistanis (n = 100)*	
		B	*Sig. T*	*B*	*Sig. T*
Truncal					
Subscapular	$p < 0.0001$	5.097	$p< 0.0001$	6.551	$p < 0.0001$
Suprailiac	$p < 0.001$	4.986	$p < 0.0005$	5.198	$p < 0.0001$
Abdomen	$p < 0.0001$	4.212	$p < 0.01$	5.257	$p < 0.0001$
Chest	$p < 0.0025$	3.332	$p < 0.01$	2.714	$p < 0.01$
Midaxillary	$p < 0.0005$	2.043	n.s.	3.891	$p < 0.0001$
Extremity					
Forearm	$p < 0.0001$	- 1.150	$p < 0.0025$	- 1.173	$p < 0.0001$
Triceps	n.s.	- 1.080	n.s.	- 1.001	n.s.
Anterior thigh	n.s.	- 1.000	n.s.	-1.026	n.s.
Medial calf	n.s.	- 1.040	n.s.	- 1.086	n.s.
Sum of al	$p < 0.005$	1.109	$p < 0.05$	1.113	$p < 0.005$

n.s. not siginificant.

Table 6: Ethnic differences in skinfolds (Europeans set to zero) after controlling for the linear and quadratic effects of age and the body mass index

Skinfold	*Sig. F change*	*Indians (n = 39)*		*Pakistanis (n = 100)*	
		B	*Sig. T*	*B*	*Sig. T*
Truncal					
Subscapular	$p < 0.0001$	7.548	$p< 0.0001$	7.288	$p < 0.0001$
Suprailiac	$p < 0.001$	6.914	$p < 0.0001$	5.778	$p < 0.0001$
Abdomen	$p < 0.0001$	6.406	$p < 0.0001$	5.916	$p < 0.0001$
Chest	$p < 0.0025$	5.295	$p < 0.0001$	3.304 ·	$p < 0.0001$
Midaxillary	$p < 0.0005$	4.157	$p < 0.0001$	4.527	$p < 0.0001$
Extremity					
Forearm	$p < 0.0001$	- 1.107	$p < 0.0025$	- 1.159	$p < 0.0001$
Triceps	n.s.	- 1.003	n.s.	- 1.024	n.s.
Anterior thigh	n.s.	- 1.083	n.s.	-1.004	n.s.
Medial calf	n.s.	- 1.040	n.s.	- 1.057	n.s.
Sum of al	$p < 0.001$	1.206	$p < 0.05$	1.142	$p < 0.0001$

n.s. not siginificant.

Thus at any given age, mean values of subscapular, suprailiac, abdomen, chest, midaxillary and forearm skinfolds are significantly different in South Asian compared to European men.

When the BMI was included in the model, multiple regression analysis indicated that the distributions of triceps, anterior thigh and medial calf in the three groups were overlapping, *i.e.*, no significant difference existed in b values between the groups. However, there was significant heterogeneity in b values between Europeans and Indian/Pakistanis for subscapular, suprailiac, abdomen, chest, midaxillary, forearm and sum of all skinfolds, Thus for any given age and BMI, mean values of subscapular, suprailiac, abdomen, chest, midaxillary and forearm skin folds are significantly different in South Asians compared with Europeans.

A noteworthy point is that the significantly greater subcutaneous adiposity (subscapular, suprailiac, abdomen, chest and midaxillary skinfolds) observed in South Asians is located in the truncal region of the body. These results clearly indicate that South Asian men have a tendency of increased accumulation of subcutaneous fat, irrespective of age and BMI, compared to European men, in the truncal region.

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