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Age Trends in Adiposity and Central Body Fat Distribution Among Adult White Men Resident in Peterborough, East Anglia, England

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A B S T R A C T

The pattern of fat distribution is related to a large number of variables of clinical importance. Many anthropometric indices have been derived which are surrogate measures of central fat distribution. However, systematic information on age variations in regional adiposity and central fat distribution is incomplete. The present study investigates the age variations in regional adiposity and five indices of central fat distribution among 262 adult White men resident in Peterborough, East Anglia, England. The five indices were studied: subscapular/triceps (STSR), abdomen/triceps (ATSR) and centripetal fat (CPFR) skinfold ratios, waist/hip ratio (WHR) and conicity index (CI). In general, the age patterns show progressive trend towards increasing central body fat distribution. The associations of age with all five central fat distribution indices were significant. These significant associations remained even after controlling for the body mass index (BMI). Therefore, this study provided evidence that there is a significant positive trend of increased central adiposity and fat distribution with increasing age in native English men. This trend is independent of BMI, which is a measure of overall adiposity. Such trends of enhanced fat accumulation in the central region of the body with age could have serious health implications especially with regard to chronic diseases like coronary heart disease (CHD), hypertension (HT) and non-insulin dependent diabetes mellitus (NIDDM). Future studies should also investigate whether the same phenomenon exists in other ethnic groups resident in Britain like South Asians who have very high prevalence of CHD and NIDDM.

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Introduction

In the recent past, it has become evident that in addition to the amount of fat in the body, its pattern of distribution is of great importance. The amount and distribution of body fat are complex traits, which are determined by a combination of genetic and environmental factors[1]. The increase of body fat content and the reduction of muscle mass seem to be the most important steps to ageing[2]. Although numerous studies worldwide have reported anthropometric characteristics of the elderly[3–9], most of these investigations have restricted their studies on individuals who are middle-aged and elderly (55 years and above). Studies on younger adults are lacking. These studies [3–9] have investigated age trends in anthropometric measures using different age categories. However, except the study of Shimokata[5], none has investigated, in detail, the age trends of various indices of central body fat distribution.

The present study investigated age-related trends of adiposity and fat distribution among adult (19+ years) White males resident in Peterborough, East Anglia, England. To the best of my knowledge, this is the first study on a native English population, to investigate age trends of a variety of central body fat distribution indices including a new index of abdominal adiposity, namely the conicity index (CI). The conicity index (CI) is another measure of central adiposity that is based on quantifying the deviation from the circumference of an imaginary cylindrical shape modeled from the height and weight of the individual[10]. It is computed from the equation[10] as follows:

$$\text{CI} = \text{Waist circumference (m)} / (0.109) \times \sqrt{\{(\text{Weight (kg)} / \text{Height (m)}\}}$$

Unlike WHR, it takes into account the overall adiposity of the individual and is also independent of hip circumference. This could be an advantage when comparing ethnic groups who differ in bone size[10].

Material and Methods

The study population of the present investigation consisted of 262 male individuals aged 19 years and above, resident in Peterborough, East Anglia, England. They belonged to the White Caucasian group as classified by the OPCS Census H form[11]. Details of the response rate and sampling technique have been published elsewhere[12]. It is sufficient to note here that random sampling method was followed and the response rate was 34.3%. All 262 individuals have been categorized into four discreet age group categories following the classification of Shimokata et al.[5], i.e., Groups I, II, III and IV. Individuals belonging to Group I (Young), Group II (Middle), Group III (Old) and Group IV (Very Old) were in the age categories of 19–39.9 years, 40–54.9 years, 55–69.9 years, and 70 years and above, respectively.

All anthropometric measurements were made by the author using standard anthropometric techniques[13]. Height, weight, four circumferences and nine skinfolds (5 central, 4 peripheral) were measured. A total of five indices were derived to study central body fat distribution. The indices were:

– Waist-hip ratio (WHR) was computed after Yassin and Terry[7]: WHR = Waist circumference in cm / hip circumference in cm;
– Conicity index (CI) was derived using the equation of Valdez et al.[10]:
$$\text{CI} = \text{Waist circumference (m)} / (0.109) \times \sqrt{\{\text{Weight(kg)} / \text{Height(m)}\}};$$
– Subscapular-triceps skinfold ratio (STSR) = Subscapular skinfold in mm / triceps skinfold in mm;

– Abdomen-triceps skinfold ratio (ATSR) = Abdomen skinfold in mm / triceps skinfold in mm;
– Centripetal fat ratio was (CPFR) computed using the equation of Nirmala Reddy[10]: Centripetal fat ratio (CPFR) = Subscapular skinfold / (subscapular + triceps skinfold) x 100.

Technical error of measurements (TEM) was calculated and the results were found to be within reference values (less than 0.9 mm for skinfolds and less than 1.0 cm for circumferences) cited by Lohman et al.[13] and Ulijaszek and Lourie[14]. Thus, TEM was not incorporated in statistical analysis. Distributions of majority of the variables were not significantly skewed. All statistical analyses were performed using the SPSS Package (SPSS/PC+ Version 5).

Results

Tertile values of a continuous variable shed insight on the nature of its distribution. Table 1 presents the first and second tertile values of all the anthropometric characteristics by age group categories. It is evident from this table that, in general, there existed an increasing trend, between the age group categories, in the five central fat distribution indices (STST, ATSR, CPFR, WHR and CI). To test whether there were any significant differences between the age group categories, analysis of variance were undertaken. The mean, standard deviation and results of analysis of variance of the anthropometric variables and indices are given in Table 2. As can be seen from the table, between the age group categories significant differences were observed in the mean values for: height ($p < 0.0001$), minimum waist ($p < 0.0001$), maximum hip ($p < 0.001$), abdomen ($p < 0.0001$) and chest circumferences ($p < 0.001$). Next, significant differences between age groups are found for subscapular ($p < 0.001$), chest ($p < 0.0001$), abdomen ($p < 0.01$) and midaxillary ($p < 0.0001$) skinfolds and for all five indices: STSR ($p < 0.0001$), ATSR ($p < 0.01$), CPFR ($p < 0.0001$), WHR ($p < 0.0001$) and CI ($p < 0.0001$). A noteworthy point is that although extremity skinfolds were similar in all groups, for all five central body fat distribution indices (STSR, ATSR, CPFR, WHR and CI) existed significant group differences. There was no significant group difference in BMI and weight. Scheffe's tests were undertaken and results revealed that for all five central fat distribution indices (STSR, ATSR, CPFR, WHR and CI) there was a significant increasing trend from Group I to Group IV. The general trend observed for all these indices was: Very Old > Old > Middle > Young.

Regression analyses of age with STSR, ATSR, CPFR, WHR and CI were performed which revealed that (Table 3) age had significant associations with all the five indices of central fat distribution (STSR, $p < 0.0001$; ATSR, $p < 0.01$; CPFR, $p < 0.0001$; WHR, $p < 0.0001$ and CI, $p < 0.0001$). Multiple regression analyses demonstrated that this significant association of age with indices of central body fat distribution remained (Table 4) even after controlling for the effect of the BMI (STSR, $p < 0.0001$; ATSR, $p < 0.01$; CPFR, $p < 0.0001$; WHR, $p < 0.0001$ and CI, $p < 0.0001$).

Discussion

Excess body fat influences health risk and increases morbidity and mortality. Interest in fat patterning has increased remarkably in recent years because of strong association with a variety of degenerative diseases like NIDDM, CHD and HT[5]. Concomitant with ageing, changes occur in body proportion, structure, as well as metabolic and physiological variables. However, the changes vary be-

TABLE 1
FIRST AND SECOND TERTILE VALUES OF ANTHROPOMETRIC CHARACTERISTICS BY AGE GROUP CATEGORIES

	Young (19.0–39.0) N=75		Middle (40.0–54.9) N=75		Old (55.0–69.9) N=93		Very Old (70+) N=36	
	1st tertile	2nd tertile	1st tertile	2nd tertile	1st tertile	2nd tertile	1st tertile	2nd tertile
Age (yrs)	29.0	33.7	46.0	51.7	61.1	64.9	71.4	73.2
Height (cm)	174.6	179.7	173.2	180.1	170.6	176.7	168.8	172.5
Weight (kg)	71.0	80.3	75.3	83.0	72.5	84.3	73.7	81.2
BMI (kg/m^2)	23.1	26.7	24.8	27.0	24.4	27.2	24.8	28.1
Circumferences (cm)								
Min. waist	81.9	88.2	89.0	93.7	88.2	97.0	90.9	98.4
Max. hip	95.0	100.1	97.8	102.4	97.6	103.0	98.5	106.0
Abdomen	85.2	92.9	91.8	97.0	91.6	100.3	94.7	103.3
Chest	94.6	101.0	100.0	104.3	98.0	105.8	99.0	104.9
Skinfolds (mm)								
Subscapular	16.3	26.9	21.7	28.4	23.7	29.1	22.1	28.9
Suprailiac	19.8	28.6	23.9	29.5	21.4	26.5	22.5	28.6
Chest	14.7	23.2	20.7	27.1	22.0	27.9	22.9	27.8
Abdomen	24.1	36.5	33.2	40.0	29.7	37.7	30.8	37.9
Midaxillary	17.1	24.1	24.7	28.9	23.8	29.5	24.3	30.1
Triceps	11.8	16.4	12.5	18.2	12.4	17.1	11.6	16.6
Forearm	5.0	6.4	5.6	6.8	5.0	6.4	5.0	6.1
Meadial calf	11.8	15.9	11.1	15.5	11.3	16.0	10.4	13.4
Anterior thigh	17.7	22.4	16.9	23.1	16.7	20.6	15.0	23.1
Central fat distribution indices								
STSR	1.20	1.61	1.48	1.90	1.54	2.05	1.55	2.21
ATSR	1.81	2.33	2.06	2.75	1.98	2.54	2.17	2.78
CPFR	54.60	61.65	59.60	65.48	60.55	67.18	60.84	68.85
WHR	0.85	0.90	0.89	0.92	0.90	0.95	0.90	0.94
CI	1.16	1.21	1.22	1.27	1.25	1.30	1.26	1.31

STSR = subscapular/triceps skinfold ratio; ATSR = abdomen/triceps skinfold ratio; CPFR = centripetal fat ratio; WHR = waist/hip ratio; CI = conicity index

tween different ethnic groups[8]. This study analyzed age trends in adiposity and central body fat distribution of 262 White men aged 19 years and above, residing in Peterborough, East Anglia, England.

Significant differences were found in the mean values for height; minimum waist, maximum hip, abdomen and chest circumferences; subscapular, chest, abdomen and midaxillary skinfolds; and all indices of central body fat distribution between the age group categories. A noteworthy point is that there was no age trend in BMI and extremity (peripheral) skinfolds. Results of multiple regression

TABLE 2
ONEWAY ANALYSIS OF VARIANCE OF ANTHROPOMETRIC CHARACTERISTICS BY AGE GROUP CATEGORIES

	Young (19.0–39.0) N = 75		Middle (40.0–54.9) N = 58		Old (55.0–69.9) N = 93		Very Old (70+) N = 36		F value
	X	SD	X	SD	X	SD	X	SD	
Height (cm)	176.6	(6.1)	176.4	(7.4)	173.3	(6.3)	171.2	(5.7)	8.4114***
Weight(kg)	78.4	(12.9)	81.3	(12.6)	78.3	(11.0)	78.4	(9.8)	0.9698
BMI (kg/m^2)	25.1	(3.6)	26.0	(3.1)	26.0	(3.1)	26.8	(3.8)	2.4036
Circumferences (cm)									
Min. waist	86.0	(9.2)	92.2	(10.4)	93.0	(8.7)	94.6	(9.2)	10.8608***
Max. hip	98.1	(6.4)	101.5	(9.7)	100.7	(6.0)	102.8	(6.9)	4.4699**
Abdomen	90.2	(10.1)	96.6	(11.9)	96.1	(8.6)	99.4	(8.9)	9.0889***
Chest	98.8	(8.2)	103.2	(8.8)	102.4	(7.4)	102.8	(7.9)	4.3731**
Skinfolds (mm)									
Subscapular	21.8	(8.7)	25.9	(8.6)	26.3	(7.9)	25.4	(6.7)	4.8322**
Suprailiac	24.7	(8.4)	26.8	(6.2)	23.8	(6.4)	25.1	(6.1)	2.2217
Chest	19.1	(7.7)	23.9	(6.8)	24.5	(7.2)	25.4	(6.9)	10.3983***
Abdomen	30.6	(11.0)	35.4	(7.9)	33.0	(7.9)	33.9	(7.9)	3.3503*
Midaxillary	21.0	(8.5)	25.9	(6.2)	25.5	(7.1)	26.8	(6.1)	8.4329***
Triceps	15.2	(5.5)	16.0	(6.4)	15.2	(5.1)	14.3	(4.7)	0.7530
Forearm	6.3	(2.2)	6.4	(1.5)	6.3	(1.9)	5.7	(1.5)	1.0498
Medial calf	14.9	(6.2)	14.=	(6.7)	14.2	(5.9)	12.5	(4.3)	1.2419
Anterior thigh	21.0	(6.7)	21.2	(7.6)	19.4	(5.8)	19.4	(7.4)	1.3548
Central fat distribution indices									
STSR	1.49	(0.48)	1.79	(0.49)	1.81	(0.54)	1.89	(0.52)	7.2862***
ATSR	2.11	(0.70)	2.43	(0.81)	2.31	(0.66)	2.53	(0.74)	3.5997*
CPFR	58.41	(7.54)	62.04	(6.55)	63.05	(7.28)	64.18	(6.58)	7.9640***
WHR	0.88	(0.05)	0.91	(0.04)	0.92	(0.05)	0.92	(0.06)	13.6484***
CI	1.19	(0.05)	1.25	(0.07)	1.27	(0.06)	1.28	(0.06)	33.0842***

* $p < 0.01$; ** $p < 0.001$; *** $p < 0.0001$
STSR = subscapular/triceps skinfold ratio; ATSR = abdomen/triceps skinfold ratio; CPFR = centripetal fat ratio; WHR = waist/hip ratio; CI = conicity index

TABLE 3
REGRESSION ANALYSES OF AGE AND CENTRAL FAT DISTRIBUTION INDICES

Dependent variable	B	SEB	Beta	t	R^2
STSR	0.0099	0.0020	0.2922	4.928***	0.0854
ATSR	0.0079	0.0028	0.1703	2.787*	0.0290
CPFR	0.1476	0.0280	0.3108	5.272***	0.0966
WHR	0.0013	0.0001	0.3736	6.495***	0.1396
CI	0.0025	0.0001	0.5404	10.356***	0.2920

* $p<0.01$; *** $p<0.0001$

TABLE 4
MULTIPLE REGRESSION ANALYSES OF AGE AND CENTRAL FAT DISTRIBUTION INDICES AFTER CONTROLLING FOR THE EFFECT OF BODY MASS INDEX

Dependent variable	B	SEB	Beta	t	R^2
STSR	0.0090	0.0020	0.2922	4.484***	0.1168
ATSR	0.0081	0.0029	0.1703	2.794*	0.0293
CPFR	0.1332	0.0278	0.2804	4.797***	0.1353
WHR	0.0010	0.0001	0.2973	6.029***	0.3848
CI	0.0022	0.0001	0.4766	10.349***	0.4635

* $p<0.01$; *** $p<0.0001$

analyses further demonstrated that age had significant positive association with all five indices of central body fat distribution, which remained even after controlling for BMI. Therefore, this study provided evidence that there is a significant positive trend of increased central adiposity and fat distribution with increasing age in native English men. This trend is independent of BMI, which is a measure of overall adiposity. Results of the present study are in concordance with the findings of a Shimokata et al.[5] who also reported an increasing trend in anthropometric measures with age in a study from Baltimore, USA.

There are no detailed population-based data from different ethnic groups living in Britain on age trends in indices of central adiposity, which include STSR, ATSR, CPFR, WHR and CI. It has been reported that patterns of accumulation of truncal fat mass with increasing age and obesity may not be generalized to all ethnic groups[15]. Studies are therefore needed to elucidate whether similar age-related trends of increasing central body fat distribution are observed among other ethnic groups like Afro-Caribbeans, Chinese and South Asians who are resident in Britain. Since the process of ageing also involves metabolic and physiological alterations, including hormonal changes, it would be interesting to undertake similar research in Britain on the female population from different ethnic groups, including native Whites.

Cross-sectional investigations like the present one can only highlight age trends, they do not study the process of ageing. Longitudinal studies on ageing and changes in anthropometric/metabolic measures are needed among different ethnic groups for better understanding the mechanism of ageing. Moreover, it should be noted that, to date, in Britain, no comparative study has investigated body fat (visceral and intra- abdominal) on Afro-Caribbeans, Chinese and South Asians, utilizing direct measures of adiposity like magnetic resonance imaging (MRI) and CT (computed tomography) scans. Such studies are required to gain new insight on anthropometric changes, particularly with respect to visceral and intra-abdominal fat, involved in the ageing process of different ethnic groups.

The trend of enhanced fat accumulation in the central region of the body with age, irrespective of the level of overall adiposity, observed in this study could have serious health implications especially with regard to chronic diseases like CHD, NIDDM and HT.

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DOBNI TREND U PRETILOSTI I SREDIŠNJOJ TJELESNOJ RASPODJELI MASTI U ODRASLIH BIJELIH MUŠKARACA STANOVNIKA PETERBOROUGHA, EAST ANGLIA, ENGLESKA

SAŽETAK

Uzorak raspodjele masnog tkiva povezan je s velikim brojem klinički značajnih varijabli. Mnogobrojni antropometrijski indeksi koriste se kao indirektna mjera središnje raspodjele masnog tkiva. Međutim, informacije o dobno povezanim varijacijama u raspodjeli tjelesne masti i danas su nepotpune. Ova studija istražuje dobne varijacije u perifernoj pretilosti, kao i pet indeksa središnje raspodjele masti u 262 odrasla bijelca stanovnika Peterborougha, East Anglia, Engleska. Ispitivani su sljedeći indeksi: omjeri kožnih nabora i to subskapuarni/triceps (STSR), abdomen/triceps (ATSR) i omjeri kožnih nabora centripetalne masti (CPER), potom omjer struk/bokovi (WHR) te indeks koniciteta (CI). Općenito, dobno vezani uzorak pokazao je progresivan trend prema povećanju središnje raspodjele tjelesne masti. Povezanost dobi i svih pet indeksa sredi-

šnje raspodjele masti bila je signifikantna. Ova značajna povezanost nije se izgubila niti nakon poravnavanja podataka za vrijednost indeksa tjelesne mase (BMI). Stoga, ova studija pruža dokaz o postojanju značajnog pozitivnog dobnog trenda porasta centralnog adipoziteta u muškaraca porijeklom iz Engleske. Ovaj trend je neovisan o BMI, koji je mjera ukupne pretilosti. Ovakvi trendovi pojačanog nakupljanja masti u središnjoj regiji tijela s dobi mogli bi imati ozbiljne zdravstvene implikacije, posebno s obzirom na kronične bolesti kao što je to koronarna bolest srca (CHD), hipertenzija (HT) i dijabetes melitus neovisan o inzulinu (NIDDM). Daljnje studije trebale bi također istražiti prisustvo istog fenomena u drugim etničkim skupinama koje žive u Velikoj Britaniji, primjerice onih porijeklom iz južne Azije koje su karakterizirane visokom prevalencijom CHD i NIDDM.