Age-Related Variation in Body Fat Distribution among Male Undergraduate Medical Students in Lagos

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ABSTRACT

Human body fat distribution is related to several variables of clinical importance. Systematic information on age variations in regional adiposity amongst young adult Nigerians is scarce in the literature. This study investigated the pattern of age-related body fat distribution amongst medical students in the urban Lagos area. Anthropometric measurements including body mass, stature, waist circumference, maximum gluteal circumference, triceps, and subscapular skinfolds were taken from 245 volunteer male undergraduate medical students aged 16 to 27 years, selected by systematic random sampling, were used to derive the following body fat indices: subscapular/triceps ratio (STSR), centripetal fat (CPR) skin folds ratio, waist-hip ratio and conicity index (CI). Data was analyzed for descriptive and inferential statistics and presented as mean, median, and standard deviation using SPSS version 14. P values were set at 0.05.

The study observed statistically significant and persistent age differences in the estimated indices of central fat distribution, even after controlling for the BMI, suggesting that BMI had limited influence on central fat distribution. The study provided evidence that there is a significant upward trend of increased central adiposity and fat distribution with increasing age in male undergraduates. Such a trend of enhanced fat accumulation in the central region of the body may have serious health implications for this population.

Keywords: Central adiposity patterns, undergraduate medical students, Nigerian

INTRODUCTION

It has become increasingly evident that in addition to the amount of fat in the body, its distribution pattern is clinically significant. The quantity and distribution of body fat are biological traits, which are determined by a complex combination of genetic and environmental factors.[1] Studies suggest that the accumulation of body fat and the reduction of muscle mass may be critical stages in the aging process.[2]

While the prevalence of overweight and obesity in adolescence based on body mass index (BMI) has increased globally over the past 10-20 years,[3-7] the BMI has been shown to systematically underestimate the prevalence of obesity in young people since it gives no indication of body fat distribution and is thus a poor proxy for central fatness.[8-11] Central body fat accumulation has been linked to an increased risk of metabolic complications.[12-13] Reports from around the globe indicate that the trends in waist circumference, a known and reliable marker for central adiposity, have increased among the youth over the past 10-20 years at a greater rate than body mass index.[14-16] In addition to waist circumference, other frequently derived indices of central body fat include the waist-hip ratio (WHR),[11] subscapular-triceps skin fold ratio (STSR), and centripetal fat ratio[14] The conicity index (CI), a less frequently estimated measure of central adiposity, is based on the quantification of the deviations from the circumference of an imaginary cylindrical shape modeled from the height and weight of the individual.[14]

Numerous other studies from around the world investigating age-related trends in body fat distribution have reported the anthropometric characteristics among the elderly.[17-22] However, similar or related studies among the younger adult population are scanty,[23-24] and fewer still, including Shimokata et al.[25] and Bose[26], have investigated, in detail, the age trends in various indices of central body fat distribution in the young adult population. There are currently no reports in the literature on the subject in this population in Nigeria and those from elsewhere in West Africa are scarce.

In this study, we used these indices to investigate the age-related patterns of adiposity and central body fat distribution among male undergraduate medical students aged 17+ years.

MATERIAL AND METHODS

Ethical clearance, Informed consent, and Sampling

Ethical clearance was obtained from the Research Ethics Committee of the College of Medicine of the University of Lagos (CMUL) with number CMUL/HREC/06/24/1502. The study sample included 245 volunteer male fit and healthy Nigerian medical students of the University of Lagos aged 16-27 years selected through a participation and consent form randomly distributed among the medical students and individually administered to each prospective participant. A random sampling method was followed and the response rate was 34.3%. All participants received a guarantee of preservation of their personal space throughout the measurement exercise.

All participants were categorized into three discreet age groups including persons under the age of 22 years (group I, N=90), 22-25 years (group II, N=90), and over the age of 25 years (group III, N=65) respectively. Nine anthropometric measurements including body mass, stature, waist circumference, gluteal maximum circumference, medial calf circumference, triceps skinfold, subscapular skinfold, and supraspinal skinfold were taken according to the protocols recommended by the International Society for the Advancement of Kinanthropometry (ISAK).[20]

A total of four indices were derived to estimate central body fat distribution including:

Waist-Hip Ratio = Waist circumference (cm)/hip circumference (cm)

Conicity index = Waist circumference (m)/ (0.109) x √Weight (kg)/ Height (m)

Subscapular: triceps skinfold ratio (STSR) = Subscapular skinfold (mm) /triceps skinfold (mm)

Centripetal fat ratio = Centripetal fat ratio (CPFR) = Subscapular skinfold / (subscapular + triceps skinfold) x 100.

Since the distributions of the majority of the variables were not significantly skewed, there was no cause for a normality test. All statistical analyses were performed using the SPSS package (SPSS/PC+ Version 5).

All anthropometric measurements were made by the author using standard anthropometric techniques.[27] 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[28]: WHR = Waist circumference in cm/hip circumference in cm;
- Conicity index (CI) was derived using the equation of Valdez et al.[30]: CI = Waist circumference (m) / (0.109) x Weight (kg)/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;

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- Centripetal fat ratio was (CPFR) computed using the equation of Nirmala Reddy[29]: 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.[31] and Ulijaszek and Lourie[32] Thus, TEM was not incorporated into statistical analysis. Distributions of the majority of the variables were not significantly skewed. All statistical analyses were performed using the SPSS Package (SPSS/PC+ Version 5).

RESULTS

Table 1 shows the first and second tertile values of all the anthropometric characteristics by age group categories. There was an increase with age in all four central fat distribution indices (STST, CPFR, WHR, and CI), in all age group categories. Although the patterns of trunk skinfold thickness were similar in all groups, all four central body fat distribution indices (STSR, CPFR, WHR, and CI) showed significant group differences. Between-group differences in BMI and body mass were not significant. Among Groups I to Group III, all four central fat distribution indices (STSR, CPFR, WHR, and CI) showed an increasing and significant trend.

Table 1: Comparison of the First and Second Tertiles of Selected Anthropometric Characteristics by Age Group in Males

	< 22yrsb		**22-25**		**>25**	
	1st TERTILE	**2nd TERTILE**	**1st TERTILE**	**2nd TERTILE**	**1st TERTILE**	**2nd TERTILE**
age (years)	18.32	21.27	22.12	24.59	25.15	26.8
Stature (cm)	164.06	181.74	165.1	177.78	170.27	178.09
Body mass (kg)	52.68	73.54	51.82	70.12	50.28	69.68
BMI(kg/m^2)	17.78	23.99	18.35	23.41	16.79	23.05
Chest circf. (cm)	78.74	92.66	78.2	89.72	83.09	92.53
Waist circf. (cm)	66	81.7	65.7	80.64	70	78.65
Max. gluteal circf. (cm)	80.9	100.08	81.7	95.8	76.6	92.63
triceps sf. (mm)	5	12.2	5	13	5	8.2
subscapular sf. (mm)	7	14.2	7.4	14.4	7.4	13
Medial calf sf. (mm)	4	10.2	4	9	4.7	5.6
supraspinale sf. (mm)	4	10	4	9.2	4	7.2
∑4 skinfolds (mm)	20	46.6	20.4	45.6	21.1	34
Conicity Index (CI)	1.07	1.21	1.018	1. 91	1.087	1.27
STSR	1	1.75	1.12	1.87	1.18	1.71
CPFR	50	63.64	52.76	65.14	54.18	63.1

Key: BMI= Body mass index; SSTR = Subscapular-Triceps skin fold ratio; CPFR= Centripetal Fat ratio; sf= Skinfold; circf = circumference

TABLE 2: Summary of Descriptive and Correlational Statistics of Subscapular and Supraspinal Skin Fold Thickness in Male Medical Students

Age in years	SUBSCAPULAR SF	SUPRASPINAL SF	PEARSON'S COEFFICIENT OF CORRELATION (r)
	Mean ± SD (Median)	Mean ± SD (Median)	
15.51 - 17.5	8.0± 0.00 (8.0)	5.0± 1.42 (5.0)	-
17.51 - 18.5	12.0± 6.68 (9.0)	7.4± 3.60 (6.3)	0.9143
18.51 - 19.5	10.4± 6.11 (8.5)	7.2± 4.90 (6.0)	0.6996
19.51 - 20.5	9.7± 2.78 (9.0)	6.1± 2.51 (5.3)	0.8647
20.51 - 21.5	11.1± 4.69(10.0)	6.7± 3.93 (6.0)	0.8647
21.51 - 22.5	10.3± 2.52 (9.5)	6.3± 2.49 (5.5)	0.8612
22.51 - 23.5	12.1± 5.59(11.5)	7.3± 4.06 (6.5)	0.9856
23.51 - 24.5	10.5± 5.01 (8.5)	5.7 ± 2.25 (5.0)	0.9222
24.51 - 25.5	8.8± 1.39 (9.0)	4.8 ± 1.27 (4.5)	0.8333
25.51 - 26.5	9.0± 0.82 (9.0)	4.5 ± 0.58 (4.5)	0
26.51 - 27.5	12.0± 6.93 (8.0)	7.3± 2.31 (6.0)	1

KEY: r= Pearson Product Moment Correlation Coefficient; S.D= Standard Deviation; SF= Skinfolds

Table 3: Summary of Descriptive and Correlational Statistics of Triceps and Medial Calf Skin Fold Thickness in Male Medical Students

Age in years	TRICEPS SF			MEDIAL CALF SF			PEARSON'S COEFFICIENT OF CORRELATION (r)
	Mean ± SD (Median)			Mean ± SD (Median)			
15.51 - 17.5	6	± 0.00	-6	5	± 0.00	-5	-
17.51 - 18.5	9.5	± 5.98	-6.5	6.3	± 2.12	-6	0.7212
18.51 - 19.5	9.7	± 6.67	-7	7.9	± 3.54	-6.5	0.7756
19.51 - 20.5	7.8	± 2.92	-6.8	6.2	± 2.95	-5	0.6934
20.51 - 21.5	8.7	± 5.25	-8	6.5	± 2.83	-5	0.5907
21.51 - 22.5	7.8	± 3.37	-7.5	6	± 2.14	-6	0.8129
22.51 - 23.5	8.4	± 4.90	-7	6.6	± 3.66	-5.5	0.9751
23.51 - 24.5	7.8	± 4.62	-6	5	± 1.10	-5	0.158
24.51 - 25.5	6.4	± 1.51	-6	5.8	± 1.92	-5	0.7184
25.51 - 26.5	6.8	± 0.50	-7	5	± 0.00	-5	-
26.51 - 27.5	7	± 3.46	-5	5	± 0.00	-5	-

KEY:r= Pearson Product Moment Correlation Coefficient; S.D= Standard Deviation; SF= Skinfolds

DISCUSSION

Tertile values of a continuous variable shed insight into the nature of its distribution (Flegal et al.).[33] Table 1 presents the first and second tertile values of all the anthropometric characteristics by age group categories. It is evident that, in general, an increasing trend exists, between the age group categories, in the four central fat distribution indices (STSR, CPFR, WHR, and CI). The mean, standard deviation, and results of correlational analysis of the anthropometric variables and indices are given in Table 2. Correlation between the subscapular and supraspinal age group categories significant differences were observed in the mean values for height ($p < 0.05$), minimum waist ($p < 0.05$), maximum hip ($p < 0.05$), abdomen ($p < 0.05$), and chest circumferences ($p < 0.05$). Next, significant differences between age groups are found for subscapular ($p < 0.001$), chest ($p < 0.0001$), abdomen ($p < 0.01$), and mid-axillary ($p < 0.0001$) skinfolds and all four centripetal fat indices STSR ($p < 0.0001$), CPFR ($p < 0.0001$), WHR ($p < 0.0001$) and CI ($p < 0.0001$). Although extremity skinfolds were similar in all groups, for all four central body fat distribution indices (STSR, CPFR, WHR, and CI) significant group differences occurred.

There was no significant group difference in BMI and weight. Scheffe's test results revealed that for all four central fat distribution indices (STSR, CPFR, WHR, and CI) there was a significant increasing trend from Group I to Group III.

Mean and Standard Deviation along with Correlation analysis of triceps and medial calf skin fold thickness in male medical students was carried out as outlined in Table 3. There is a strong positive correlation between triceps and medial calf skinfold thickness from age 17.51 to 25.5.

Excess body fat influences health risks and increases morbidity and mortality. Interest in fat patterning has increased remarkably in recent years because of its strong association with a variety of degenerative diseases like NIDDM, CHD, and HT.[5] Concomitant with aging, changes occur in body proportion, structure, as well as metabolic and physiological variables. However, the changes vary between different ages and social strata.[9] This study analyzed age trends in adiposity and central body fat distribution of 245 male undergraduate medical students aged 17 years and above, residing in Lagos, Nigeria. Significant differences were found in the mean values for height; minimum waist, maximum hip, and chest circumferences; triceps, medial calf, subscapular, and supraspinal (supra iliac) 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 Pearson's product moment correlational analyses further demonstrated that age had a significant positive association with all four indices of central body fat distribution. Therefore, this study provided evidence that there is a significant positive trend of increased central adiposity and fat distribution with increasing age in Nigerian undergraduate medical students. 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 Shimokata et al.[25] who also reported an increasing trend in anthropometric measures with age in a study from Baltimore, USA. It agrees with those of Bose,[26] who also reported an increasing trend in anthropometric measures and central adiposity indices among young men in East Anglia in the United Kingdom.

BMI has been conventionally used to define and classify overweight and obesity but does not account for the wide variation in the distribution of fat in the body mainly in the prediction of intra-abdominal fat accumulation. There are no detailed population-based data from adolescents living in Nigeria on age trends in indices of central adiposity, which include STSR, CPFR, WHR, and CI. Hence, we investigated their role as surrogates of WC and abdominal fat in predicting metabolic abnormalities. There is considerable debate in the literature as to whether anthropometric measures may perform differently for the prediction of metabolic abnormalities in diverse ethnic and geographic populations. Few studies in populations of Asian origin have reported WHR to have superior predictive capacity than WC only, while similar studies in North American populations have reported WC to be superior to WHR.[15]

It has been reported that patterns of accumulation of truncal fat mass with increasing age and obesity may not be generalized to all age groups and social strata.[19] Studies are therefore needed to elucidate whether similar age-related trends of increasing central body fat distribution are observed among other categories of undergraduate students who are residents in Nigeria. Since the process of aging also involves metabolic and physiological alterations, including hormonal changes, it would be interesting to undertake similar research in Nigeria on the female population from different age groups and social strata including children, adolescents, and the elderly. Cross-sectional investigations like the present one can only highlight age trends; they do not study the process of aging. Longitudinal studies on aging and changes in anthropometric/metabolic measures are needed among different age and social groups for a better understanding of the mechanism of aging. Therefore, it is imperative to explore and conduct comparative studies which investigate body fat (visceral and intra-abdominal) in young adults utilizing direct measures of adiposity like magnetic resonance imaging (MRI) and CT (computed tomography) scans. Such studies are required to gain new insight into anthropometric changes, particularly concerning visceral and intra-abdominal fat, involved in the aging process of different age 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 in the future, especially for chronic diseases like CHD, NIDDM, and HT.

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