

Sonographic Quantification of Abdominal Adipose Tissue Thickness in Hypertensive Obese Subjects of Yoruba Tribe in Lagos State, Nigeria

Abdul Fatai Kolawole Bakre¹, Anthony Chukwuka Ugwu² and Michael Promise Ogolodom^{3*}

¹Esteem Diagnostics Medical Services Ltd, Lagos State, Nigeria

²Radiography and Radiological Sciences Department, Faculty of Health Sciences and Technology, Nnamdi Azikiwe University Anambra State, Nigeria

³Rivers State Hospitals Management Board, Port Harcourt, Rivers State, Nigeria

*Corresponding author: Michael Promise Ogolodom, Rivers State Hospitals Management Board, Port Harcourt, Rivers State, Nigeria, Tel: +2348039697393; E-mail: mpos2007@yahoo.com

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Abstract

Background: This study was designed to quantify abdominal adipose tissue thickness in hypertensive obese subjects using ultrasound and correlate it with biochemical and anthropometric parameters to establish reference range values for adipose tissue thickness in these subjects in this locality.

Materials and methods: A prospective study design was adopted in this study and it was conducted at Esteem Diagnostic Medical Services Limited (EDMSL) Lagos State, Nigeria. Ethical approval was obtained from Research Ethics Committee of EDMSL. An informed consent was also obtained from each patient. Information obtained from the patients was treated with high level of confidentiality. A convenience sample size of 112 volunteers was recruited in this study. Standard protocols and parameters were used to obtain the data. Data were processed and analyzed using SPSS version 20, descriptive and inferential statistics. Statistical significance was set at $p < 0.05$.

Results: The study population consisted of 41.96% ($n=47$) males and 58.04% ($n=65$) females with age mean of 41.4 ± 10.2 years. The Subcutaneous Adipose tissue (SAT) and Visceral Adipose tissue (VAT) mean \pm SD and p -values for male and female subjects were (SAT= 30.93 ± 7.97 mm, $p=0.012$, and SAT= 37.08 ± 14.42 mm, $p=0.617$) for male and female respectively while the (VAT= 73.00 ± 8.61 mm, $p=0.214$ and VAT= 71.61 ± 17.40 , $p=0.006$) for male and female respectively. The correlation of VAT with age, BMI, lipid profile and fasting blood sugar levels in male and female hypertensive subjects were assessed and the results showed VAT(Age: Male, $r=0.122$, $p=0.416$, female, $r=0.082$, $p=0.517$), VAT(LDL: Male, $r=0.092$, $p=0.541$, Female, $r=0.112$, $p=0.375$), VAT(HDL: Male, $r=0.049$, $p=0.745$, Female, $r=0.198$, $p=0.113$).

Conclusion: Female preponderance was noted in this study. Male subjects had higher values of VAT thickness than their female counterparts, while females were seen with higher values of SAT thickness than their male counterparts. Higher value of blood sugar increases VAT and SAT thickness in female obese subjects more than in male obese subject.

Keywords: Abdominal adipose tissues; Hypertensive; Obese

Introduction

Adipose tissue is a type of connective tissue consisting of adipose cells, which are specialized in production and storage of large fat globules, which compose of mainly glycerol esters, thus a main reservoir of fat in man [1,2]. The main role of adipose tissue is to store energy in the form of lipids, cushion and insulate the body and it is a major endocrine organ that produces hormones such as leptin, estrogen, resistin, and the cytokine [2]. Excessive deposition of adipose tissues in the body can affect another organ of the body and may lead to diseases [3,4]. In man, the percentage of brown adipose tissue found in the body decrease with age. Adipose tissue contains 80% fat: the remaining 20% is water, protein, and minerals [5-8]. Abdominal adipose tissue composes of mainly subcutaneous, preperitoneal and intraperitoneal fat and retroperitoneal fat masses separated by delineation along the dorsal margin of the intestine and the ventral surface of the kidney [2,9,10]. Anatomically, Visceral Adipose Tissue (VAT) exist predominately in the mesentery and omentum and drains directly through the portal circulation to the liver [8, 11,12]. Visceral adipose tissue when compared with Subcutaneous Adipose Tissue (SAT) consist of cellular, vascular, innervated and contains a vast aggregate of inflammatory and immune cells, lesser pre-adipocytes, differentiating capacity and greater percentage of large adipocytes [2,12,13].

Overweight and obesity result from the disparity between energy intake and energy consumption. Fat is the main storage form of energy, obesity represents an excess body fat [14,15]. Obesity is a strong risk factor for hypertension, type 2 diabetes, dyslipidemia and ischemic heart disease [2,16-18]. It is evaluated by measuring the body mass index (BMI) and waist circumference (WC). A BMI of 18.0-24.9 is considered normal, 25.0-29.9 is considered overweight, a BMI of 30 kg/m² or greater is considered obese and BMI greater than 40 kg/m² as very or morbidly obese [2,19]. Individuals with a body mass index (BMI) exceeding a healthy range (25.0-29.9 kg/m²) have a much greater risk, such as hypertension, heart disease, diabetes

mellitus, lipoma, chronic musculoskeletal problems, obstructive sleep apnoea, asthma and cancer [20-23]. The effect of racial differences in the prevalence of generalized obesity (BMI, kg/m² of 30 or above) has been an area of study in the United States [6,7]. Waist circumference is used to determine the distribution of body fat, while central or abdominal obesity is an independent predictor of morbidity and mortality associated with obesity. There are disparities between adipose tissue found in subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT) thickness existing in the abdominal cavity [12,24-26].

The worldwide prevalence of obesity case is about 15% and in the United States, over two thirds of the total is overweight [15,27]. These differences by race have also been reported among children and adolescents. World Data Atlas [28] equally reveals that the prevalence of adult obesity in Nigeria is 16.2% in female and 5.9% in the male. Akarolo-Anthony et al. [29] in his study of 1058 adults' staff of government worksite in Abuja reported that overall prevalence of overweight or obesity (body-mass index ≥ 25 kg/m²) was 64% (74% of the women and 57% of the men). Adipose mass and the anatomic distribution of adipose tissue strongly influence the risk of multiple diseases, e.g. cancer, hypertension, cardiovascular diseases, heart disease etc. Men are more likely to have fat stored in the abdomen than the female due to sex hormone differences and female sex hormone causes fat to be deposited in the buttocks, thighs, and hips [3,6-8,30]. At menopause the estrogen produced by ovaries declines, fat then migrates from their buttocks, hips, and thighs to their waists [15,30,31].

Computed Tomography (CT) scan is an excellent imaging modality of choice for assessment of adipose tissue thickness and no other technique is considered to meet its highest criteria of accuracy [32]. Although is expensive, involves high dose of ionizing radiation and not readily available in all localities. Armellini et al. [33] revealed that Ultrasound has been found useful in the quantification of abdominal adipose tissues thickness in human subjects (North American Association for study of Obesity) [34]. This suggests that the amount of abdominal fat can be more reliably evaluated by ultrasound measurements than by anthropometric measurement. Ultrasound scanning has been adopted for its numerous advantages over other techniques due to its portability and availability [34,35]. Obesity is a rising medical problem all over the world and there is increasing interest in understanding the racial and ethnic differences in adiposity in specific body depot as a way to explain differential health risks associated with Obesity. Though the clinical assessment of the BMI and Waist Circumference is considered reasonable method [36], it may sometimes give a misleading result. Hence direct quantification of body fat is very important. Despite the popularity of B-Mode Ultrasound scan measurement of adipose tissue thickness among the Caucasians [26], there is a paucity of literature and data on the use of ultrasound in the assessment of adipose tissue thickness in Nigeria. To the best of the researchers' knowledge, this has not been investigated in obese Yoruba subjects in Lagos State. This study is aimed at using ultrasound to determine the pattern of abdominal adipose tissue thickness in hypertensive obese adults and correlate it with

anthropometric variables like BMI, WC and BP and biochemical parameters in Yoruba tribe in Lagos State, Nigeria.

Materials and Methods

A prospective study design was adopted in this study and was conducted at Radio-Diagnostic Department of Esteem Diagnostic Medical Services Limited (EDMSL), Lagos State, Nigeria. Ethical approval was obtained from Research Ethics Committee of the study center. The procedure was explained to the volunteers and verbal and writing consent was obtained from each patient. All information gotten from the patient were treated with high level of confidentiality and used for the purpose of this study only. A total of 112 adults hypertensive obese volunteers of Yoruba ethnic origin resident in Lagos state, Nigeria were recruited using volunteer non-probability sampling technique based the following inclusion criteria;

- Only adult hypertensive obese volunteers of Yoruba tribe resident in Lagos state.
- Those who were able to stand erect for height, weight, abdominal, and waist circumference assessment.
- Only subject between the ages of 18-65 years, and all those that do not meet the inclusion criteria were excluded.

The support of the nurse, physicians, laboratory scientists and research assistant were properly sought. The subjects were carefully assessed using the inclusion criteria before taking their height, weight for body mass index (BMI), waist circumference (WC) blood pressure (BP) and blood sample for lipid profile (LP) and fasting blood sugar (FBS). Anthropometric data including hip circumference, abdominal circumference, blood pressure, height, and weight were taken and BMI calculated. Biochemical parameters i.e. total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol and fasting blood sugar levels were measured. The sonographic examinations were performed with Toshiba core Vision PRO, 2003 ultrasound machine using 3.5 MHz sector transducer (Visceral Adipose tissue measurement) and 7.5 MHz linear transducers (Subcutaneous Adipose tissue measurement). Subcutaneous and visceral adipose tissue thicknesses were measured with the use of electronic caliper on freeze images of abdominal adipose tissue by trained Sonographers. All the variables were measured using standard protocols, parameters and instruments, and the obtained values were recorded using data capture sheet. Subcutaneous and visceral adipose tissue thickness was quantified and normality test conducted using Shapiro Wilk test. Both descriptive and inferential statistics were used for statistical data analysis. Means \pm standard deviations (SD) and range were used for description. The body mass index (BMI) was obtained by expressing the weight in Kilogram over the square of the height in meters (Kg/m²). The VAT thickness and SAT thickness were correlated with the anthropometric variables, biochemical parameters and demographic variables of the volunteers in all the categories using Pearson's correlation test and scatter diagrams were also generated. A p value <0.05 was set as a statistical level of significant.

Results

The male to female ratio of the subjects studied is 1:1.4 which is 41.96% (n=47) males and 58.04% (n=65) females. The age mean and standard deviation of the subjects was 41.4 ± 10.2 years with age ranged between 18-65 years. The mean ± SD of BMI of subjects were 37.05 ± 7.72 Kg/m² and 40.77 ± 6.24 Kg/m² for male and female respectively (**Table 1**). The waist circumference (WC) mean ± SD were 88.96 ± 14.08 cm and 96.34 ± 31.96 cm for male and female respectively, while the hip circumference (HC) were 97.07 ± 14.20 cm and 101.63 ± 41.32 cm for male and female respectively (**Table 1**). The mean ± SD of SAT thickness were 28.65 ± 4.80 mm and 33.3 ± 12.63 mm for male and female respectively, while the VAT thickness was 69.52 ± 11.48 mm for male and 66.21 ± 17.41 mm for female (**Table 1**). The mean ± SD for all participants for both VAT and SAT thickness were 65.3 ± 15.68 mm and 33.67 ± 11.60 mm respectively (**Table 2**). A comparison of the VAT thickness, SAT thickness between the gender, the SAT and VAT mean ± SD and p-values for male and female subjects were (SAT=30.93 ± 7.97 mm, p=0.012, and SAT=37.08 ± 14.42 mm, p=0.617) for male and female respectively while the (VAT=73.00 ± 8.61 mm, p=0.214 and VAT=71.61 ± 17.40, p=0.006) for male and female respectively (**Table 3**). The VAT and SAT thickness were evaluated with respect to the fasting blood sugar levels of the participants, the result showed subjects with high fasting blood sugar level as highest 56.25% (n=63) and 43.75% (n=49) for those with normal fasting blood sugar level (**Table 4**).

Table 1 Demographic and anthropometric variables.

Variables	Gender	
	Male	Female
Age (Years)	43.85 ± 8.54	41.29 ± 9.71
Height (m)	1.66 ± 0.08	1.63 ± 0.07
Weight (kg)	100.79 ± 17.41	108.01 ± 14.80
BMI (Kg/m ²)	37.05 ± 7.72	40.77 ± 6.24
WC (cm)	88.96 ± 14.08	96.34 ± 31.96
HC (cm)	97.07 ± 14.20	101.63 ± 41.32
SAT (mm)	28.65 ± 4.82	33.30 ± 12.60
VAT (mm)	69.52 ± 11.48	66.21 ± 17.41

Table 2 Sonographic quantification of abdominal adipose tissue (VAT and SAT) thickness of the volunteers.

Parameter	Mean Value (Mean ± SD)
VAT (mm)	65.3 ± 15.68
SAT (mm)	33.67 ± 11.60
Age (Years)	41.37 ± 11.23
BMI (Kg/m)	39.39 ± 8.07

Table 3 Comparison of sonographic quantification of vat and sat thickness in male and female hypertensive subjects. Comparison

of sonographic quantification of vat and sat thickness in male and female hypertensive subjects.

Parameters	Gender		P-Value
	Male	Female	
SAT (mm)	30.93 ± 7.97	37.08 ± 14.42	0.012
VAT (mm)	73.00 ± 8.61	71.61 ± 17.44	0.617
Age (Years)	43.94 ± 8.52	41.03 ± 10.36	0.214
BMI (Kg/m ²)	40.77 ± 6.24	40.77 ± 6.23	0.006

For high fasting blood sugar level cases, the VAT and SAT thickness mean ± SD were 68.45 ± 51.0 mm and 70.02 ± 16.80 mm for male and female respectively, while the SAT thickness mean ± SD was 27.61 ± 8.61 mm for male and 32.44 ± 11.30 mm for female (**Table 4**). The WC mean ± SD in high fasting blood sugar subjects were 85.50 ± 12.63 cm and 96.42 ± 13.61 cm for male and female respectively (**Table 4**). The correlation of VAT with age, BMI, lipid profile and fasting blood sugar levels in male and female hypertensive subjects were assessed and the results showed VAT(Age: Male, r=0.122, p=0.416, female, r=0.082, p=0.517), VAT(LDL: Male, r=0.092, p=0.541, Female, r=0.112, p=0.375), VAT(HDL: Male, r=0.049, p=0.745, Female, r=0.198, p=0.113) (**Table 5**).

Table 4 Comparison of VAT and SAT thickness with fasting blood sugar and anthropometric variables between the gender.

Parameters	Fasting blood sugar level			
	Normal=49		High=63	
	Male	Female	Male	Female
VAT (mm)	48.21 ± 12.51	43.30 ± 17.66	65.45 ± 51.0	70.02 ± 16.80
SAT (mm)	26.08 ± 8.28	28.06 ± 11.80	27.61 ± 8.61	32.44 ± 11.30
BMI	39.84 ± 14.12	36.76 ± 11.34	36.34 ± 5.12	40.5 ± 7.83
WC	86.80 ± 14.60	102.31 ± 70.71	85.50 ± 12.65	96.42 ± 13.61
HC	102.25 ± 13.11	105 ± 11.60	104.30 ± 12.63	110.75 ± 16.70

Table 5 Correlation of VAT with age, MBI, lipid profile and fasting blood sugar levels of both male and female hypertensive subjects.

Parameters	Correlation Coefficients (r)		P-Value
	Male	Female	
Age	0.122	0.082	0.416 0.517
BMI	0.297	0.305	0.043 0.014
HC	0.521	0.077	0.000

			0.541
WC	0.473	0.057	0.001 0.651
Tc	0.125	0.042	0.404 0.742
Tr	0.015	0.042	0.919 0.839
HDL	0.049	0.198	0.745 0.113
LDL	0.092	0.112	0.541 0.375
FBS	0.086	0.058	0.505 0.646

Discussion

Demographic variables were determined and their correlations with biochemical parameters, sonographic and anthropometric measurements were also evaluated. Female volunteers were highest when compared to their male counterparts in this study. This is in agreement with World Health Organization finding which state that obesity is common in females than males [37]. Male obese subjects were taller than their female counterpart and also, female hypertensive obese subjects have heavier weight than their male in this study. World Data Atlas [28] also reported high percentage of obesity in Nigerian female population when compared to their male counterpart. According to World Data Atlas, female and male obesity were 16.2% and 5.9% respectively. Our finding is also in keeping with the finding of a similar study conducted by Akarolo-Anthony et al. [29], which reported 74% of female obesity and 57% of male obesity. The study further revealed a significantly higher body mass index (BMI) in female hypertensive subjects than their male counterparts [38].

In this study, the mean values of adipose tissue thickness in all the participants were 31.67 mm \pm 11.58 mm and 67.35 mm \pm 15.68 mm SAT and VAT respectively. This result is in similar with previous study conducted by Diniz et al. [39] which established mean and standard deviations of 26.4 mm \pm 1.37 for subcutaneous fat thickness and 68.40 mm \pm 23.80 for visceral fat thickness in a study that involved 50 patients indistinct of gender. This study further revealed mean and standard deviation of VAT thickness in the male and female subjects as 69.52 mm \pm 11.48 mm and 62.21 mm \pm 17.41 mm and, mean and standard deviation of SAT thickness as 28.65 mm \pm 4.82 mm and 33.31 mm \pm 12.60 mm in male and female obese subjects respectively. The mean value of VAT thickness in male was generally higher when compared with the female volunteers and it is found to be statistically significant ($p < 0.05$). Furthermore, the value of SAT thickness in female obese subjects was generally higher when compared with their male counterparts. This finding is consistent with the study conducted by Ronald Stolk et al. [40]. In their study, they reported mean (\pm SD) intra-abdominal fat distances in the men and the women as 95.0 \pm 25.0 mm and 8.2 \pm 25.0 mm, with the subcutaneous fat of 26 \pm 14.0 mm and 34.0

\pm 19.0 mm in the men and the women respectively. This shows that male's obese subjects are more prone to having a higher VAT thickness depot in their abdomen than females while female's obese subjects are more prone to having higher SAT thickness depot in their abdomen than male's subjects. This indicates that female obese subjects are more prone to having a higher SAT thickness values than male subjects. This result is in agreement with Kershaw and Flier [3] who reported that men are more likely to have fat stored in the abdomen than the female due to sex hormone differences.

With regard to adipose tissue thickness, Lipid profile and fasting sugar levels in hypertensive obese subjects, the result showed higher values of VAT and SAT thickness in female obese subjects with higher values of fasting blood sugar compared with their male counterparts with normal values of fasting blood sugar values. This finding disagreed with similar study conducted by Kershaw and Flier [3], which reported higher VAT values in male obese subjects. This indicates that obese subjects with higher fasting blood sugar (FBS) value are more prone to having higher values of VAT thickness thereby increasing their metabolic risk for diseases. When considering the adipose tissue thickness and anthropometric variables in hypertensive obese subjects, the result of this study showed significant positive correlations in SAT thickness values with HC and WC in hypertensive male obese subjects, while there was no significant correlation observed in SAT thickness values with HC and WC in hypertensive female obese subjects. This implies that weight has a significant effect on SAT thickness values in obese subjects since BMI is directly proportional to weight and inversely proportional to the square of its height. Furthermore, this study showed positive correlation in VAT thickness values with BMI, HC and WC in hypertensive male subject.

Gender differences in abdominal visceral adipose tissue thickness and subcutaneous tissue thickness in hypertensive obese subjects was evaluated and our finding showed that there were more female hypertensive subjects than their male counterparts. It equally revealed a higher VAT thickness in male subjects when compared with the female subjects and higher values of SAT in female subjects when compared with their male counterparts in hypertensive subjects. This indicates that male obese subjects are more prone to having higher VAT thickness values than female obese subjects while the female obese subjects are more prone to having higher values of SAT thickness than male obese subjects. A similar finding has been reported by Diniz et al. [39] and Ribeiro-Filho et al. [41]. They reported in their separate studies, higher values of visceral adipose tissue thickness in male when compared with their female counterparts and higher values subcutaneous adipose tissue thickness in female compared with their male counterparts.

Conclusion

Conclusively, female preponderance was noted in this study. Male subjects had higher values of VAT thickness than their female counterparts, while females were seen with higher values of SAT thickness than their male counterparts. Furthermore, thicker values of VAT and SAT thickness were documented in female subjects with higher values of estimated

fasting blood sugar when compared with the male subjects with higher values of estimated fasting blood sugar. From this study, it is ascertained that higher value of blood sugar increases VAT and SAT thickness in female obese subjects more than in male obese subject, which predisposes females more to the metabolic risk and cardiovascular diseases than male. There were significant positive correlations in SAT thickness values with HC and WC in hypertensive male obese subjects, while there was no significant correlation observed in SAT thickness values with HC and WC in hypertensive female obese subjects.

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