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SEXUAL DIMORPHISM IN VISCERAL ADIPOSITY MEASURES, PARAMETERS AND BIOMARKERS OF METABOLIC SYNDROME AMONG HAUSA ETHNIC GROUP IN KANO, NIGERIA

*Asuku, A.Y.,¹ Danborno, B.,² Akuyam, A.S.,³ Timbuak, J. A.² and Adamu, L.H.¹

¹Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Bayero University, Kano, P.M.B. 3011, Kano State, Nigeria

²Department of Human Anatomy, Faculty of Medicine, Ahmadu Bello University, Zaria, Nigeria

³Department of Chemical Pathology, Faculty of Medicine, Ahmadu Bello University, Zaria, Nigeria

*Corresponding Author: abdullahiyusufasuku@gmail.com; +2348032878100

ABSTRACT

Visceral adipose tissue is considered the most important anatomic site of adipose tissue aggregation and is considered the hall mark of metabolic syndrome (MetS) phenotype. The aim of the study was to determine sexual dimorphism in visceral adiposity measures, parameters and biomarkers of metabolic syndrome among Hausa ethnic group in Kano, Nigeria. The study was a cross sectional study including 465 participants of Kano, with a mean age of 34.4 years and 32.0 years for males and females respectively. Systematic random sampling technique was employed for subject recruitment. Weight, height, waist circumference (WC) and body mass index BMI were obtained using standard protocol. Overnight fasting blood sample was obtained for high density lipoprotein cholesterol (HDL-c), total cholesterol (TC), triglyceride (TG), low density lipoprotein cholesterol (LDL-c), uric acid and adiponectin estimation using standard laboratory protocols. Visceral adipose tissue was estimated using visceral adiposity index (VAI) and WC. It was observed that VAI, FBG, HDL and TC were significantly higher in females. There was no significant sex difference in WC, TG, and LDL, Serum adiponectin, uric acid, systolic and diastolic blood pressure. In conclusion, the serum uric acid and adiponectin levels did not show sexual dimorphism. Only some of the MetS parameters are sexually dimorphic. While VAI was higher in females, WC did not show sexual dimorphism.

Keywords: Biomarkers, metabolic syndrome indices, sexual dimorphism, visceral adiposity

INTRODUCTION

The metabolic syndrome is a cluster of interrelated common clinical disorders, including hypertension, hyperglycemia, glucose intolerance and dyslipidaemia in addition to obesity (Moller and Kaufman, 2005). It is defined based on the presence of three or more of the following criteria: abdominal obesity with waist circumference >94cm for men or > 80cm for women (Grundy *et al.*, 2005), triglycerides >150 mg/dl, high density lipoprotein cholesterol (HDL-cholesterol) < 40 mg/dl for men or <50 mg/dl for women (Bergman *et al.*, 2006), blood pressure >130/85 mmHg (Tremblay *et al.*, 2004) and fasting glucose >100 mg/dl (Grundy *et al.*, 2005) It is documented that accumulation of excess body fat, particularly intra-abdominal visceral fat promotes the development of the metabolic syndrome (Kissebah *et al.*, 1982; Fujioka *et al.*, 1987; Grundy *et al.*, 1999; Kahn *et al.*, 2000).

Adiponectin is a novel peptide abundantly expressed in adipose tissue (Matsuzawa, 2005). This adipocytokine is very attractive because of its anti-atherogenic (Okamoto *et al.*, 2002; Ouchi *et al.*, 2001), anti-diabetic (Yamauchi *et al.*, 2002; Stefan *et al.*, 2003) and anti-inflammatory (Maeda *et al.*, 2002; Engeli *et al.*, 2003) properties. It's a biomarker of MetS as low plasma levels characterize both obesity and adverse metabolic parameters (Hu *et al.*, 1996; Arita *et al.*, 1999; Hotta *et al.*, 2000; Weyer *et al.*,

2001; Engeli *et al.*, 2003). While hyperuricemia is associated with adverse metabolic states (Billiet *et al.*, 2014), hyper adiponectinemia has been proven to be protective (Kadowaki *et al.*, 2006; Lara-castro *et al.*, 2007; Ghantous *et al.*, 2015).

Ethnicity and race are known to affect visceral adipose reserve (Lear *et al.*, 2007; Misra and Khurana, 2009), serum adiponectin (Weyer *et al.*, 2001; Stefan *et al.*, 2003) and uric acid (Mark *et al.*, 2012). Because of the close association between visceral adipose tissue and these biomarkers with metabolic syndrome components, their ethnic variation may affect measures and sexual differences of the metabolic syndrome indices in a population. Moreover, since the various components of MetS are associated with different but interrelated complications, the extent of sexual difference in each of the components may be a pointer to the susceptibility of each gender to a particular complication of the MetS. There is paucity of data on the sexual difference in visceral measures of adipose tissue, MetS biomarkers and indices especially among the Hausa population. The aim of the study was to determine sexual dimorphism in visceral adiposity measures, parameters and biomarkers of metabolic syndrome among Hausa ethnic group in Kano, Nigeria.

MATERIALS AND METHODS

Target Group and Sample Size

Systematic random sampling technique was employed in selecting 465 [266 males (57%) and 199 females (43%)] original Hausa ethnic group of Kano based on a history of at least two parental generation being Hausas from Kano. Participants were recruited from outpatient units of Murtala Muhammad specialist Hospital, Khadija Memorial Hospital, SU clinic, General Hospital Dawakin - Tofa and the old campus of Bayero University, Kano. The study included only subjects in the age range of 18 years to 68 years. Subjects with pregnancy, abdominal or pelvic space occupying lesions, congenital and / or acquired spinal or digit deformity, were however excluded. Subjects that were on medications that could interfere with any component of metabolic syndrome were also excluded. Ethical approval was obtained from Kano state hospitals management board and written informed consent obtained from the subjects.

Anthropometry and Derived Indices

Height was measured to the nearest 0.1cm as the vertical distance between the standing surface and the vertex of the head while the subject was standing erect in the frank forth plane and without shoes using a stadiometer. The weight was measured in kilograms using a digital weighing scale while the subject is in light clothes. The body mass index was be calculated by dividing the weight in kilograms by the square of the height in meters and the result expressed in kg/m². Waist circumference was measured in centimeter with a non- stretchable plastic tape horizontally placed over the unclothed abdomen at the narrowest point between the lowest rib and the iliac crest.

Visceral adiposity was estimated using the sex specific mathematical model (Visceral Adiposity Index) proposed Amato and Giordano, (2010). The index is reported to be highly correlated with visceral adiposity measured by sophisticated methods such as magnetic resonance imaging and computer tomography scan, it is therefore presumed to be a reliable predictor of adipose tissue reserve (Zhang *et al.*, 2013a).

$$VAI(Male) = \frac{WC}{39.68 + (1.88 \times BMI)} \times \frac{TG}{1.03} \times \frac{1.31}{HDL}$$

$$VAI(Female) = \frac{WC}{36.58 + (1.89 \times BMI)} \times \frac{TG}{0.81} \times \frac{1.31}{HDL}$$

Where WC is waist circumference, TG is serum triglyceride, HDL is serum high density lipoprotein, and BMI is body mass index.

Measurement of Serum Parameters

For the estimation of serum TC, TG, LDL and HDL - c, FBG, uric acid and adiponectin, blood specimen was collected from 161 subjects after 10 to 12 hours of fasting via superficial veins of the upper limb. From each selected subject, 5ml of venous blood sample was collected using a sterile 21G needle fitted with syringe. Blood collection was done during the morning hours to avoid the effect of diurnal variation or circadian rhythm in the blood parameters to be measured. Standard technique of venipuncture and universal safety precaution was employed. Blood sample was transferred into a plain blood specimen bottle and allowed to stand until it was properly clotted. The blood samples were preserved in an ice pack insulating container to preserve the temperature and then transported to the lab immediately after each exercise of sample collection. Sample was then centrifuged at 300rpm for 5 minutes after which serum was separated and immediately used for analysis.

Serum glucose was measured using the enzymatic method of Trinder (1969). Serum TC, TG and HDL concentrations were measured using enzymatic method by Wybenga, *et al.* (1970). Serum uric acid concentration was measured using Caraway method (1955). Serum adiponectin concentration was determined using the Solid - Phase ELIZA method (Pischon *et al.*, 2003).

Statistical Analyses

The data were expressed as mean ± standard deviations, Student’s t test was used to compare between males and females. SPSS version 20 (IBM Corporation, NY) software was used for statistical analyses and P < 0.05 was set as level of significance.

RESULTS

Table 1 shows the sexual dimorphism in anthropometric parameters. There was statistically significant sex differences in height and weight, with males having higher mean values. No significant sexual dimorphism was observed in age, BMI and waist circumferences.

Table 1: Sexual dimorphism in anthropometric parameters

Variables	Male (n=266)			Female (n= 199)			t	P Value
	Mean	SD	Min-max	Mean	SD	Min-max		
Age	34.45	13.52	18-68	32.06	15.18	18-65	1.79	0.075
Height(cm)	169.15	6.27	142-182.3	158.53	6.83	136.9-175	17.39	<0.0001
Weight (Kg)	63.03	12.28	40.5-98.3	55.86	12.99	36-108.9	6.08	<0.0001
BMI	21.98	3.93	14.52-34.33	22.19	4.7	12.96-39.15	-0.52	0.602
WC (cm)	77.28	11.17	57- 111	76.02	13.00	51-118.5	1.12	0.261

BMI: body mass index, Standard deviation, WC; waist circumferences

From Table 2 no statistically significant sex difference was observed in the mean values of serum uric acid, adiponectin, LDL – c and TG. In FBG, TC and HDL a statistically significant higher was observed in the female participants.

Table 2: Sex difference in the metabolic syndrome serum biomarkers and indices

Variables	Male (n=120)			Female (n= 41)			t	P value
	Mean	SD	Min-max	Mean	SD	Min-max		
Uric Acid	5.51	1.95	3.1-11.3	6.03	2.42	2.9-10.10	-1.38	0.17
Adiponectin	23.28	5.96	7.8-33.90	22.55	7.45	14.4-33.9	0.63	0.52
FBG	84.67	24.73	53.6-187.2	100.63	34.9	54.6-176.4	-3.19	0.0017
TC	174.35	32.31	123.7-256.1	187.32	43.85	127.3-290.7	-2.02	0.045
HDL- c	44.1	6.32	28-54.1	47.83	6.71	38.9-60.6	-3.21	0.0016
TG	117.18	31.76	74.3-196.5	121.83	29.25	80.4-165	-0.83	0.41
LDL- c	106.81	32.44	58.14-192.82	115.12	44.05	54.36-214.46	-1.29	0.2

FBG: fasting blood glucose, TC: total cholesterol, HDL – c: high density lipoprotein cholesterol, TG: triglyceride, LDL – c: low density lipoprotein cholesterol VAI was significantly higher in females.

Figure 1 shows that no statistically sexual dimorphism in systolic and diastolic blood pressure. However, statistically significant higher visceral adiposity index (VAI) was observed in female compared to male counter parts

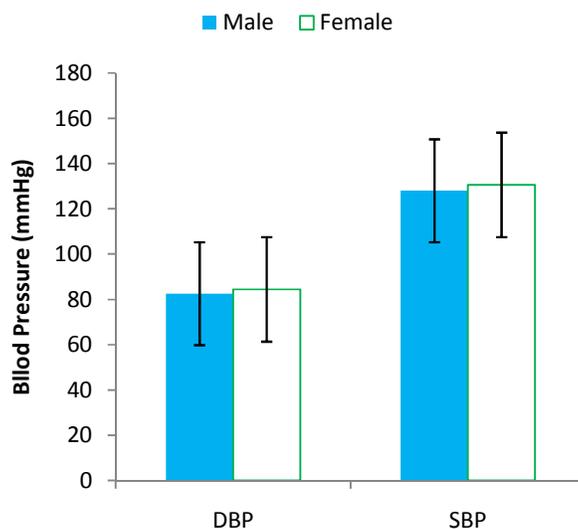


Figure 1: Sexual dimorphism in systolic and diastolic blood pressure

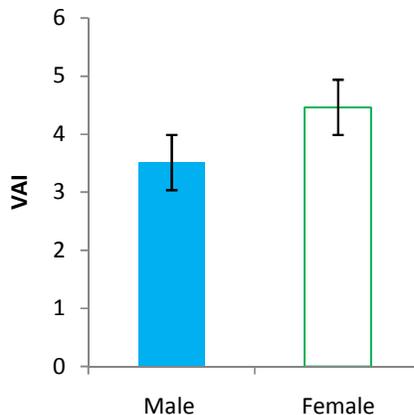


Figure 2: Sexual dimorphism in visceral adiposity index (VAI). P < 0.05

DISCUSSION

The significantly higher mean serum concentration of FBG and TC observed in females of this study may be a pointer to the higher incidence of adverse metabolic profile in the females compared to males. This impression is strengthened by the higher mean value of visceral adiposity in females as measured by VAI which has been shown to be the hall mark of MetS phenotype (Bay, 2011). Similar to this study, many previous studies reported a higher mean value for HDL – C in females when compared to males (Sabir *et al.*, 2013).

The observation from this study that VAI is higher in females slightly deviates from previous studies (Kuk *et al.*, 2005; Amato *et al.*, 2010; Amato and Giordano, 2014) which were conducted on other populations that differ from those of this study in terms of race, ethnicity and environmental influence and these variations in the characteristics of the study population may be the basis of this deviation observed. Salomon *et al.* (2011) showed that differences in methods employed for visceral fat estimation may yield different results. Therefore, since various observers employed different technique, this may account for differences in findings. Also, because the study included women in the reproductive age, the female subjects are likely to have laxated anterior abdominal wall muscles resulting from pregnancies and deliveries and as such likely to have raised WC measurement.

Since WC is a component of the sex specific model employed in this study for estimating visceral fat, this may account for the higher values of VAI observed in females of this study and may probably represent an inherent draw back in this model proposed by Amato and Giordano, (2014). This means that the accuracy of this model may be limited in some subjects exemplified by multiparous women in whom other factors other than intra abdominal visceral fat may contribute to the value of WC measurement. In keeping with this study however, Andreas *et al.*, (2013) used VAI as the tool for visceral adipose tissue estimation and showed the mean value to be higher in females.

In this study, unlike many studies comparing the mean values of uric acid and adiponectin in males and females, serum uric acid and adiponectin showed no statistically significant difference in their mean values. As independent biomarkers of MetS, SUA have been shown to be higher in males (Zhang *et al.*, 2013b), while adiponectin is higher in females (Pedersen *et al.*, 2004; Mattsson and Olsson, 2007). In this study, there was a slight deviation from this trend in that, no significant difference was observed in the mean values of SUA and adiponectin. The lower level of SUA

in females reported in many studies is attributed to the uricosuric effect of estrogen (Nicholls *et al.*, 1973) and the higher level of adiponectin in females is also thought to be associated with levels of circulating estrogen (Pedersen *et al.*, 2004; Mattsson and Olsson, 2007). Since the level of estrogen significantly drops post menopaually (Lovejoy *et al.*, 2008; Keller *et al.*, 2010), body functions driven principally by this sex hormone may demonstrate a trend reversal.

Considering the age group of subjects recruited for this study, women falling within the post menopaual age range were included and this may explain the absence of significant sexual dimorphism observed for SUA and adiponectin in this particular study. Further, since the indicators of adverse metabolic profile especially the VAI was significantly higher in females, it means the serum level of protective biomarker (adiponectin) will likely decrease while that of SUA will increase in females. This may explain the seemingly reversed trend of SUA and adiponectin seen in this study.

CONCLUSION

The study revealed that visceral adipose tissue measured by VAI, serum TC, FBG and HDL are higher in females. WC, TG, LDL, uric acid, adiponectin and both systolic and diastolic blood pressure did not show sex differences.

RECOMMENDATION

Similar studies on other ethnic groups in Nigeria should be conducted to find out if the sexual dimorphism in MetS indicators observed in this study can be applied to other Nigerians.

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Conflict of Interest:

The authors declare that there is no conflict of interest.

Authors' contributions: Asuku, A.Y: concepts, design, definition of intellectual content, literature search, data acquisition and analyses, manuscript preparation, editing and review. Danborn, B: design, definition of intellectual content, manuscript preparation, editing and review. Akuyam, A.S: design, definition of intellectual content, manuscript preparation, editing and review. Timbuak, J. A: definition of intellectual content, manuscript preparation, editing and review. Adamu LH: definition of intellectual content, data analyses, manuscript preparation, editing and review.

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