RELATIONSHIP BETWEEN BODY ADIPOSITY INDEX AND SERUM GLYCEMIC LEVEL AMONG POST MENUPAUSAL WOMEN IN MURITALA MUHAMMAD SPECIALIST HOSPITAL KANO, NIGERIA

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ABSTRACT
Body adiposity index (BAI) is documented to exhibit significant relationship with the component of metabolic syndromes (MetS) including serum glucose. The relationship between BAI and serum glucose among postmenopausal women has not been well studied. This study was aimed at determining the relationship between BAI and serum glycemic level among postmenopausal women. The study design was observational cross sectional. Fasting serum glucose was obtained via superficial vein venipuncture after at least eight hours of meal and was analysed following standard biochemical procedure. Standard techniques for anthropometric measurement were used in obtaining the appropriate parameters. Chi-square was used to determine the relationship between body mass index (BMI) and clinically accepted categorical subdivision of fasting blood sugar (FBG). A total of 156 postmenopausal women with mean age of 62.70 ± 12.84 years, height (1.58 ± 0.07) m, weight (67.30 ± 17.68) kg, hip circumference (99.94 ± 12.75) cm, waist circumference (86.56 ± 14.25) cm, BAI (32.61 ± 6.78), BMI (27.05 ± 6.90) kg/m^2 and fasting blood sugar (FBS) (5.21 ± 2.78mmol/L) were assessed in the current study. There was significant positive correlation between BAI and BMI (r = 0.877, P = 6.97x10^{-51}) and not between BAI and FBG (r = 0.026, P = 0.748). In conclusion, BAI was not significantly associated with serum glycemic level among post-menopausal women.
Key words: Glycemea, Adiposity index, Body mass index, Menopausal, Association

INTRODUCTION
Obesity is a frequent co-morbid condition associated with excessive increase in weight (Dennis, 2016). During the last century there has been numerous changes involving different aspect of people's life style such as changes in diet and level of physical activities (Berentzen *et al.,* 2013). These changes lead to obesity and high adiposity which are associated with metabolic syndrome, diabetes mellitus (DM) and cardiovascular disease (Berentzen *et al.,* 2013)

Serum glycemic level is the concentration of glucose present in the blood (Ross *et al.,* 2008). Glucose is a simple sugar and approximately 4 grams of glucose are present in the blood of a 70-kilogram (150 lb) human at all times (*Wasserman, 2009)*. The body tightly regulates blood glucose levels as a part of metabolic homeostasis and it is stored in skeletal muscle as well as liver cells in the form of glycogen (Wasserman, 2009). In fasted individuals, blood glucose is maintained at a constant level at the expense of glycogen stores in the liver and skeletal muscle (Lai *et al.,* 2009).

Menopause is a normal condition that all women experience as they age (Wegienka and Baird, 2005). The term "menopause" can describe any of the changes a woman goes through either just before or after she stops menstruating and it marks the end of the females reproductive period and it is characterized by inability of the ovary to release egg every month (Mathieu *et al.,* 2009). A woman is born with a finite number of eggs, which are stored in the ovaries in which estrogen and progesterone hormones that control menstruation and ovulation are produced (Caldwell *et al.,* 2007; Eliyas, 2017). Post-menopause is characterized by a decrease in the level of estrogen hormone in addition to the menopausal feature of complete cessation of ovulation and menstrual cycles (Davidson *et al.,* 2011).

Physiologically, estrogen stimulate fatty acid catabolism and so the postmenopausal decrease in postmenopausal decrease in estrogen level causes an accumulation of fatty acid, especially in the area of the abdomen which is described as central obesity (Nelson, 2013).

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The increased incidence of diabetes, cardiovascular disease, and osteoporosis among post-menopausal women has also been postulated to be related to the low levels of estrogen in them (Rouen, 2009).

Diabetes mellitus (DM) which is characterized by persistently high blood glucose level is a major cause of morbidity and mortality worldwide. The relationship between the body adiposity index (BAI) with blood glucose has not been well studied in worldwide, especially among postmenopausal women. Risk of diabetes mellitus may increase in older age groups and since postmenopausal women constitute a good number of people in the older age, exploring more anthropometric tools for estimating risk of DM is justified. The study may identify a relationship between BAI which is an inexpensive anthropometric feature and blood glucose level among postmenopausal women. Thus, this can find great use in the clinics for the assessment of diabetes risk among post-menopausal women. The aim of the study was to determine the relationship between body adiposity index and serum glucose level among post-menopausal women in Murtala Muhammad Specialist Hospital.

MATERIALS AND METHODS
Study design
The study was a cross sectional observational study. Consecutive sampling technique was used for subject selection. The study was conducted at the medical laboratory of Murtala Muhammad Specialist Hospital, Kano Nigeria. This hospital was chosen because of the large number of patients that are reviewed every day because it is one of the largest and affordable health facility in the state. The inclusion criteria included any postmenopausal (cessation of monthly period >12 consecutive months) female subjects attending MMSH as outpatients who gave an informed consent to participate in the study. An introductory letter was obtained from the department of Human Anatomy which accompanied the research proposal to the ethics committee of the state ministry of health. Ethical approval was obtained before the commencement of the study.

Anthropometric measurements and indices
Height was measured to the nearest 0.1cm as the vertical distance between the surface on which the participant was standing erect without shoes and the vertex of the head using a stadiometer (Price *et al.*, 2006). Body weight was measured in kilograms using a weighing scale while the subject was in light clothing and standing erect on the weighing scale (Mueller *et al.,* 1991). Hip circumference (HC) was measured using an un-stretchable measuring tape with an accuracy to the nearest 0.1 cm at the level of the maximum extension of the buttocks posteriorly in a horizontal plane, without compressing the skin (Sebo *et al.*, 2015).

The body adiposity index (BAI) was calculated using the equation suggested by Bergman *et al.,* (2011) BAI= ((hip circumference (cm)) / ((height (m))$^{1.5}$)-18).

Measurement of Biochemical parameters
Fasting blood samples were obtained via superficial vein venipuncture after 8 h of fasting. Serum glucose was measured in the laboratory using Active Accucheck glucometer®.

Statistical Analysis
Data were presented as mean ± standard deviation. Categorical variables were expressed as frequency and percentage. Statistical package for social science (SPSS) version 22 was used for statistical analysis and P<0.05 was considered significant. Pearson correlation and chi-square test were used for correlation between serum glycemic level, body adiposity index and body mass index depending on whether the data was continuous or categorical data, respectively.

RESULTS
The mean values for age (62.70 years), height (1.58 m), hip circumference (99.94 cm), weight (67.30 kg), fasting blood sugar (5.21 mmol/L), body mass index (27.05 kg/m^2), Body adiposity index (32.61), waist circumference (86.56 cm) are presented in Table 1. The correlation between the different parameters measured in quantitative values were evaluated using Pearson's correlational statistics and the result were presented in Table 2.

The correlation between weight, HC, BMI, BAI and WC were high as well as statistically significant. The correlation between weight and BMI (r = 0.953),weight and HC (r = 0.909), and, HC and BMI (r = 0.908) respectively, were the strongest among all the positive correlations that were statistically significant and these were followed by the correlation between HC and BAI (r = 0.897), BMI and BAI (r = 0.877), BMI and WC (r = 0.861), weight and WC (r = 0.858), and,weight and BAI (r = 0.744) respectively.

Table 1: Measures of central tendency for age, blood glucose level and measurements of anthropometric features among postmenopausal women

Variables	Minimum	Maximum	Mean ± SD
Age (years)	46	105	62.70±12.84
Height (m)	1.41	1.80	1.58±0.07
HC (cm)	65.5	133.0	99.94±12.75
Weight (kg)	30.60	116.60	67.30±17.68
FBG (mmol/L)	2.90	29.50	5.21±2.78
BMI	12.41	49.17	27.05±6.90
BAI	16.91	52.93	32.61±6.78
WC	59.0	122.0	86.56 ± 14.25

HC=Hip circumference, FBG= Fasting blood glucose, BMI=Body mass index, BAI=Body adiposity index, SD=Standard deviation, WC= Waist circumference n=156

Table 2: Correlation between some anthropometric parameters, age and blood glucose levels of the study participants (n=156)

	WEIGHT(kg)	HC (cm)	HEIGHT(m)	FBG(mmol/L)	BMI	BAI	AGE	WC(cm)
WEIGHT(kg)	1							
HC (cm)	0.909**	1						
HEIGHT(m)	0.276**	0.137	1					
FBG(mmol/L)	-0.072	0.085	-0,131	1				
BMI	0.953**	0.908**	-0,020	-0.039	1			
BAI	0.744**	0.897**	-0.312**	-0.026	0.877**	1		
AGE	-0.244**	-0.276**	-0.161*	0.000	0.210**	-0.191*	1	
WC(cm)	0.858**	0.813**	0.079	-0.020	0.861**	0.735**	0.166	1

**correlation is significant at 0.01, *. Correlation is significant at the 0.05 level, FBG= fasting blood glucose, BMI= body mass index, BAI= body adiposity index, HC= Hip circumference, WC= waist circumference

When the correlational assessment for BMI and BAI was carried out based on the clinically defined categories of FBG, the association became stronger for categories of normal (non-diabetics) (r = 0.884) and diabetic patients (r = 0.920) (Table 3). In addition, when the same evaluation was carried out based on clinically defined categories of BMI it was only the normal and obese BMI categories that had a statistically significant correlation with the latter stronger than the former (Table 4). Thus, suggesting that the correlation between BAI and BMI was strongest among obese persons that have diabetes level of FBG. The persons with normal BMI weighingpersons that are categorized as having prediabetes level of FBG also have a strong correlation between BAI and BMI.The correlation between BAI and FBG, as well as that of BMIand FBG were not statistically significant(P≥0.05) and these results remained same even after reevaluating the quantitative Pearsons correlation based on clinically described categories of fasting blood glucose as well as BMI (Tables 5 and 6). The evaluation of the association between BMI (four and two) categories and FBG (two) categories by the use of Chi square was also not statistically significant (Table 7).

Table 3: Pearson correlation between BAI and BMI when data is categorized according to clinical definition of FBG of the participants recruited at MMSH (n=156)

FBG Categories	Variables	R	P
Normal	BAI	0.884**	0.000
	BMI		
Prediabetes	BAI	0.728**	0.000
	BMI		
Diabetes	BAI	0.920**	0.000
	BMI		

**. Correlation is significant at the 0.01 level (2-tailed), BAI=Body adiposity index, FBG=Fasting blood glucose

Table 4: Pearson correlation between BAI and BMI based on the different categories of BMI among participants recruited at MMSH

BMI Categories	Variables	r- value	p- value
Underweight	BAI	0.213	0.396
	BMI		
Normal	BAI	0.430**	0.003
	BMI		
Overweight	BAI	0.248	0.089
	BMI		
Obese	BAI	0.678**	0.000
	BMI		

**. Correlation is significant at the 0.01 level (2-tailed), BAI=Body adiposity index, BMI=Body mass index, (n=156)

Table 5: The Pearson correlation between body adiposity index and fasting blood glucose when data is categorized according to different clinical definitions offasting blood glucose(n=156)

FBG Categories	Variables	r- value	p- value
Normal	BAI	0.025	0.787
	FBG		
Prediabetes	BAI	-0.022	0.929
	FBG		
Diabetes	BAI	-0.274	0.304
	FBG		
Normal	BAI	0.025	0.787
	FBG		
Abnormal	BAI	-0.216	0.213
	FBG		

BAI=Body adiposity index FBG=Fasting blood glucose, Abnormal FBG category is made up of Prediabetes and diabetes categories of particpants

Table 6: The Pearson correlation between body adiposity index and fasting blood glucose based on different categories of body mass index (underweight, normal weight, overweight and obese) among the participants

BMI Categories	Variables	r- value	p- value
Under weight	BAI	0.385	0.115
	FBG		
Normal weight	BAI	-0.124	0.417
	FBG		
Over weight	BAI	-0.108	0.465
	FBG		
Obese	BAI	-0.093	0.542
	FBG		

BAI=Body adiposity index FBG=Fasting blood glucose, (n=156)

Table 7: The association between body mass index (four and two categories) and fasting blood glucose (two categories) among postmenopausal women

BMI Categories	FBG Categories		Total	x^2	df	p
	Normal	Abnormal				
Underweight	14	4	18			
Normal	38	7	45			
Overweight	37	11	48	2.308	3	0.511
Obese	32	13	45			
Total	121	35	156			
Normal	38	6	44			
Abnormal	83	29	112	2.727	1	0.099
Total	121	35	156			

BMI= Body mass index, FBG= Fasting blood glucose, n=156

DISCUSSION

The observation from the present study that the mean BMI and BAI of the participant were 27.05 ± 6.90 and 32.61 ± 6.78 is similar to the reports from an earlier study among postmenopausal Caucasian, African American and Filipina women (Djeneba *et al.,* 2014). It was also observed that the mean FBG was 5.21 ± 2.78 which is within the expected range as reported in a previous study among participants of Hausa ethnic group in Kano, Nigeria (Asuku *et al.,* 2017). The The percentage of total adipose tissues measured by Dual energy X-ray Absorptiometry was more strongly correlated with BAI than BMI, which themselves are also correlated (Godoy-Matos *et al.,* 2012). Another study attempted to validate the relationship between BAI and anthropometric parameters among Asians and it was identified that ethnic differences in the level of correlation with the hip circumference and height exist (Zhao *et al.,* 2013).

The results of the current study revealed that BAI and BMI were significantly correlated (P≤0.05). This result is similar to that of an earlier study that the body adiposity index was correlated with body mass index observed among postmenopausal Caucasian, African American, and Filipina women (Djeneba *et al.,* 2014).Another study also reported that BMI was a better tool for predicting body adiposity in Korean women (Yeon-Ah*et al.,* 2014). Nevertheless, the current study identified that the strength of correlation was highest among obese post- menopausal women that have a diabetes level of FBG and this was putatively a novel finding.

There was no correlation between FBG and BAI in this study irrespective of the BMI as well as the FBG category of the patient evaluated. This result was not similar to the finding in the literature in which BAI had a weak correlation with FBG (Asuku *et al.,* 2017). BAI also had a current study evaluated the utility of BAI as a measure of adiposity and the analyses revealed that BAI was significantly correlated with other (waist circumference, hip circumference and BMI) anthropometric measures of adiposity. An earlier study demonstrated that BAI could be used to determine the fat content in patient with adipose tissue scarcity, such as individual with familial partial lipodystophy, thus emphasizing on the correlational finding in the current study (Godoy-Matos *et al.,* 2012). weak correlation with fasting glucose when compared to the correlation values with other indices of adiposity (Nobrega *et al.,* 2012). This literature findings are in sharp contrast to the finding in the current study as well as another literature report that revealed that the percentage change in BAI following weight loss had been significantly associated with percentage change in leptin, but not with percentage change in fasting blood glucose (Elisha *et al.,* 2013). These differences may be explained by difference in Ethnic origin of the study population.

Conclusion:
It can be concluded from the present study that the mean BAI, BMI and FBG of the postmenopausal women studied were similar to those reported in earlier studies. There was no relationship between BAI and FBG. However, there was a positive statistically significant (P < 0.05) correlation (r = 0.877) between BMI and BAI.

RECOMMENDATION

•   A larger sample study involving community and hospital-based population recruited via simple random approach to eliminate any bias should be studied to validate the findings of the present study.

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