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ORIGINAL RESEARCH

Sex-Related Differential Prevalence of Central Obesity in Diabetes Mellitus: A Multi-centred Survey in North-Central Nigeria

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Abstract

Background: Contrary to the old dictum that central obesity is more common among men than women, recent reports have shown a gradual reversal of this trend, as suggested by some studies.
Objective: To compare the prevalence of central obesity among men and women with Diabetes mellitus in North-Central Nigeria.
Methods: This multi-centred, cross-sectional study was conducted across 20 hospitals in Abuja, Nasarawa State, and Niger State, involving 1040 participants. Some obesity indices (body mass index, waist circumference and waist-to-height ratio) were measured.
Results: The prevalence of central obesity (waist circumference criterion) was significantly higher in the females compared to male participants (89.6% vs 51.6%, $\chi^2 = 1231.37$, $p<0.001$), similar to the prevalence determined by waist-height ratio criterion (female vs male, 88.8% vs 71.5%, $\chi^2 = 58.83$, $p<0.001$). Following correction for age, duration of diabetes mellitus, blood pressure, blood glucose, and glycated haemoglobin using logistic regression, female gender remained a significant determinant of central obesity (OR = 2.76, 95% CI 1.81-3.83, p = 0.004).
Conclusion: The prevalence of central obesity was higher among women than men in a cross-section of patients with diabetes mellitus in North-Central Nigeria.

Keywords: Central Obesity, Diabetes mellitus, Gender, Waist Circumference, Waist-to-Height ratio.

Introduction

The prevalence of obesity is increasing worldwide, leading to a proportionate increase in the prevalence of diabetes mellitus (DM) and cardiovascular diseases (CVD). [1] According to the World Health Organization estimates, in 2016, 13% of adults worldwide were obese, while 11% of men and 15% of women were estimated to be obese. [1] The same report concluded that the prevalence of obesity worldwide had tripled between 1975 and 2016. In Nigeria, the prevalence of obesity has been variedly reported, ranging from 18% to 64%, with higher prevalence among urban dwellers and females. [2]

Central obesity has stronger pathophysiologic links with DM, CVD, and other obesity-related diseases. [3] It was previously generally understood that the prevalence of central obesity tended to be higher among men than women, leading to such coinages as "android obesity", referring to central obesity, and "gynoid obesity", referring to predominant fat distribution around the thighs, hips, and gluteus which is more common in women. [3-5]

This specific partitioning of adipose tissue in women has been linked to the actions of oestrogen, which also protects them from excessive visceral and ectopic fat accumulation. [3] Some local reports have reported the male preponderance of central obesity. [4-6] However, there has been a gradual trend of reports demonstrating a higher prevalence of central obesity among women. [7-17] In a systematic review and meta-analysis by Bashir *et al.,* [8] 39% of adults, about 46.8 million in Nigeria, are estimated to be centrally obese. They further analysed that 54% of adult females and 13% of adult males are centrally obese. In a regional sub-analysis, Bashir *et al.* [8] added that the prevalence of central obesity in southern Nigeria was 48%, significantly higher than the 18% prevalence reported for northern Nigeria. However, no previous report specific to North-Central Nigeria specifically studied sex-related preponderance of central obesity. Against this backdrop, this study was designed to determine the prevalence of central obesity among men and women with DM in a multi-centred survey in North-Central Nigeria.

Methods

This was a multi-centred, cross-sectional study conducted over 18 months (September 2018 to February 2020) involving 18 secondary and tertiary hospitals in Abuja, one (1) tertiary hospital in Nasarawa State, and one (1) general hospital in Niger State. The study was carried out as part of the routine clinic activities in accordance with the 2013 amended Helsinki Declaration. [18] Informed consent was obtained from the participants.

Inclusion criteria included all persons with DM, while exclusion criteria included those who were pregnant, those with fluid retaining states such as chronic kidney disease and chronic liver disease, those with other disease conditions that can cause abdominal swelling and those who have never been diagnosed with DM. Informed written consent was obtained from each participant. A non-probability consecutive sampling method was adopted, resulting in a total of 1042 study participants from the 20 hospitals. However, two respondents had incomplete results and were excluded from the statistical analysis. Relevant details of history and physical examinations were entered into Excel sheets.

In each hospital, two health assistants were trained to measure height, weight, and waist circumference. The same models of height/ weight measuring scales and the same type of measuring tapes were used, as described below. A combination scale (model number RGZ-120, produced by Jiangsu Suhong Medicals LTD, Jiangsu, China, Jun. 2016) was used to measure height and weight. Participants were asked to stand straight with feet joined together on the foot platform, heels against the backboard, with neither headgear nor footwear. The head was aligned such that an imaginary straight line between the superior border of the external auditory meatus and the lower orbital margin was parallel to the horizontal ground. The participant was instructed to breathe in, followed by a height measurement to the nearest 0.1cm. Then, each lightly dressed participant was asked to reposition feet apart and parallel, face straight ahead with arms by the sides, followed by the weight measurement to the nearest 0.5kg. Body mass index (BMI) was determined by the formula: weight (Kg)/height^2 (m^2) expressed in kg/m^2. [19]

Subsequently, waist circumference (WC) was measured using a non-stretchable measuring tape. With the help of a trained assistant, the tape was wrapped around the waist over the mid-point between the lowest point of the lowermost rib and the upper margin of the iliac crest and held parallel to the horizontal ground. At the end of expiration, the WC was measured to the nearest 0.1 cm. The International Diabetes Federation criteria were used to identify central obesity as WC≥ 80 cm for females and WC≥ 94 cm for men. [19] Waist-to-Height ratio (WHtR) was calculated using the formula WC (m) / height (m); a value of > 0.5 denotes central obesity for both males and females. [20]

Statistical analysis was done using IBM-SPSS version 23 (by IBM SPSS Co. Ltd., NY, US; 04 March 2015). The Chi-Square test was used to compare the prevalence of central obesity between males and females. Logistic regression was used to control for confounders such as blood glucose, systemic blood pressure, and duration of diabetes disease. The level of significance was set at $P \leq 0.05$.

Results

A total of 1042 study participants were recruited, but two (2) respondents had incomplete data and were excluded from the statistical analysis. The mean age of the participants was 52.9 ± 11.8 years, with no significant difference in the mean age of the males and females (p = 0.084), as shown in Table I. The duration of DM was significantly longer among the males than the females (102 vs 89 months, p = 0.014). The female participants had significantly higher body mass index (BMI) compared to the males (29.0 vs. 26.2 Kg/m2, p<0.001). However, there was no significant gender difference in systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting plasma glucose (FPG), 2-hour postprandial plasma glucose (2HrPP) and glycated haemoglobin (HbA1c) between males and females (Table I).

Table I: Mean values of selected clinical and laboratory parameters

	Female	*Male*	*Total*	*p-value*
	Mean±SD	Mean±SD	Mean±SD	
Age (Years)	52.38±11.81	53.66±11.82	52.91±11.82	0.084
Duration (months)	89.00±15.37	102.15±16.98	94.46±15.22	0.014
BMI (Kg/m²)	28.95±5.82	26.28±4.94	27.84±5.62	<.001
SBP (mmHg)	130.14±21.01	130.49±20.02	130.29±20.60	0.790
DBP (mmHg)	79.97±12.12	79.31±10.63	79.69±11.52	0.368
FPG (mmol/L)	9.33±4.32	9.57±4.71	9.43±4.4	0.388
2HrPP (mmol/L)	12.74±6.48	12.86±6.21	12.79±6.37	0.763
HbA1c (%)	8.18±2.40	8.67±2.69	8.39±2.53	0.221

BMI - Body Mass Index, WC - Waist Circumference, SBP - Systolic Blood Pressure, DBP - Diastolic Blood Pressure, PP - Pulse pressure, RtABI - Right Ankle-Brachial Index, LtABI - Left Ankle-Brachial Index, FPG - Fasting Plasma Glucose, 2HrPP - 2-Hour Postprandial Glucose, HbA1c - Glycated Haemoglobin.

The prevalence of central obesity (WC criterion) was significantly higher in the females compared to male participants (89.6% vs 51.6%, $\chi^2 = 1231.37$, p<0.001), similar to the prevalence obtained by using the WHtR criterion (88.8% vs 71.5%, $\chi^2 =$ 58.83, p<0.001) (Table II). Following correction for age, duration of DM, blood pressure, blood glucose, and glycated haemoglobin concentration, logistic regression showed that the female gender remained a significant

determinant of central obesity (OR = 2.76, 95%CI 1.81-3.83, p = 0.004), with a higher OR than males (OR = 2.16, 95% CI 1.23-3.02, p = 0.013) (Table III).

Table II: Comparison of the prevalence of obesity by gender using different obesity indices

Obesity indices	*Female*	*Male*	*Chi-square*	*p*
BMI	41.9%	21.8%	1091.77	<0.001
WC	89.6%	51.6%	1231.37	<0.001
WHtR	88.8%	71.5%	58.83	<0.001

BMI - Body Mass Index, WC - Waist Circumference, WHtR - Waist-to-Height ratio

Table III: Logistic regression of the predictors of central obesity

	B	*SE.*	*Wald*	*df*	*p*	*Exp(B)*	*95% CI for EXP(B)*	
							Lower	Upper
Female	2.565	1 .396	2.034	1	.004	2.760	1.809	3.826
Male	2.347	1.351	1.992	1	.013	2.163	1.229	3.018

B – Regression coefficient, SE - Standard Error, df - Degree of freedom, p - level of significance, Exp(B) - Odds ratio, CI - Confidence Interval.

Discussion

This study shows the prevalence of central obesity determined by waist circumference (WC) and waist-to-height ratio (WHtR) criteria was significantly higher among females than male participants. This is in tandem with a gradual trend of recent reports demonstrating female preponderance of central obesity. [7-17] The reason for this gradual trend reversal is unclear. However, one of our hypotheses includes a possible role played by gender equity or inequality. For instance, in a deliberate attempt to ensure gender equity in the socio-political realm of society, the increasing social roles performed by women may have been exposing them to unusual physical and psychosocial stress, unhealthy lifestyles, including increased "junk" food consumption, alcoholism, smoking, and propensity to drug or substance abuse, all of which may predispose them to dysmetabolic states including central obesity, glucose intolerance, dyslipidaemia, and systemic hypertension. This scenario is prevalent in more developed climes, which may be the reason a similar higher female preponderance of central obesity is being reported in some studies [8-17] and possibly, gradually creeping in on the developing nations as shown in the present study and the report by Bashir *et al.* [7] However, hypothesising from another viewpoint, gender inequality; lower socioeconomic level of some women especially in the less developed climes may also be associated with undue psychosocial stress, unbalanced diet, sedentary lifestyle, poor physical and health education which can predispose to central obesity.

Furthermore, the old dictum that portrayed the lower prevalence of central obesity in females has been linked to the effect of endogenous oestrogen on fat distribution predominantly around the hips, thighs, and gluteus. [3-5] Is it possible that the gradual reversal of the gender trend in central obesity may have been occurring via the diminutive effects of emerging environmental threats on the metabolic benefits of endogenous oestrogen in women? For instance, increasing environmental pollution with Persistent Organic Pollutants (POP) as a result of industrialisation

and widespread use of synthetic chemicals has been demonstrated to cause obesity and other dysmetabolic states via dysregulation of adipogenesis regulators (PPARγ and C/EBPα), nuclear receptors effect, epigenetic modifications, and increased subclinical inflammation. [21] It can, therefore, be hypothesised that the POPs may interfere with and diminish the metabolic benefits of endogenous oestrogens in women, predisposing them to central obesity. More studies will be required to ascertain this hypothesis.

In a different vein, the female preponderance of central obesity in the present study is limited to persons with diabetes mellitus. Is it also possible that diabetes mellitus has led to the loss of oestrogenic benefits that favour fat distribution around the hips, thighs, and gluteus? It may, therefore, mean that the female preponderance of central obesity may be more prevalent in persons with one or more dysmetabolic disturbance(s) than metabolically healthy individuals. This is an area open for further research. The strength of this study includes the reasonably large sample size, the heterogeneity of the population in the Federal Capital Territory Abuja that cuts across the various socioeconomic strata and ethnic groups, which can be representative of Nigeria and make the findings generalisable; and the use of more than one index of central obesity which produced similar results of statistical analysis. The limitations of this study include the fact that it is an observational study, and therefore, far-reaching conclusions about causal relationships may be limited. Other limitations include interpersonal errors of the different observers involved in the anthropometric measurements across the various centres and the non-availability of hi-tech indices of obesity like dual-energy X-ray absorptiometry, computed tomography, and magnetic resonance imaging to serve as gold standard indices of central obesity. Also, healthy controls were not used to ascertain whether a female preponderance of central obesity applies to metabolically healthy populations. Therefore, future studies should include comparing the prevalence of central obesity in metabolically healthy and metabolically unhealthy individuals across the gender divide.

Conclusion

The prevalence of central obesity is higher among women than men in a cross-section of persons with diabetes mellitus in North-Central Nigeria.

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Authors' Contributions: MRR, LY, SR and AFE conceived and designed the research. LY, SR, OSO and SR did a literature review. LY, OSO, SR and OK did data analysis and interpretation. LY, SR, OSO, and OK drafted the manuscript, while AFE revised the draft for sound intellectual content. All the authors approved the final version of the manuscript.

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