

Correlation of Body Mass Index and Chronic Kidney Disease Staging Among Adult Diabetic Patients in a Referral Teaching Hospital, Nigeria- a Cross-sectional Study

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Abstract

Background: Chronic kidney disease (CKD) is one of the microvascular complications of diabetes mellitus. MDRD equation was used to evaluate estimated glomerular filtration (egfr) rates and was applied in the study group. Obesity and hypertension were evaluated as risk factors.

Methods: The study was a cross-sectional in which adult diabetic patients were consecutively recruited. The study spanned from March 2019 to February 2021. Height, Weight and body mass index (BMI) were measured. Egfr was used to ascertain the renal function.

Results: There were 87 males and 136 females. The mean age of participants was 55.25 ± 11.20 years. The mean weight and height were $71.75 \pm 15.17\text{kg}$ and $157 \pm 21.23\text{cm}$ respectively. The prevalence of obesity was 32.8% which consisted of Obesity Class 1, 2 and 3. The mean BMI was 39.041kg/m^2 . The prevalence of CKD (using $\text{egfr} \leq 60\text{ml/min/1.73m}^2$) was 43.1%. The mean egfr was $78.16 \pm 58.30\text{ml/min/1.73m}^2$. CKD staging consisted of G1- 27.3%, G2-30.3%, G3A -22.0%, G3B-14.4%, G4-4.5%, G5- 1.5% . The correlation between BMI and MDRD classes did not show statistical significance ($X^2 = 22.726$, $p=0.592$). However, correlation of sex and MDRD showed a significant correlation ($(X^2 = 39.026$; $p=0.000)$). The age and BMI also showed significant correlation ($X^2 = 11.725$; $p=0.039$).

Conclusion: Chronic kidney disease is prevalent among diabetic participants studied. By using MDRD equation, G1, G2 and G3 were the common CKD stages. Obesity was also prevalent among the participants. The variables such as age and sex correlated significantly with the MDRD staging in CKD.

INTRODUCTION

Chronic kidney disease is one of the non- communicable diseases that is taking a negative toll among individuals living in both developing and developed nations of the world. The pooled prevalence of chronic kidney disease in Nigeria was 13.7% (95% CI 11.1–16.5%) in a nationwide screening survey by Nigerian Association of Nephrology. [1] Other studies in different parts of Nigeria showed the prevalence of CKD was 3.6% & 7.8% in South Western Nigeria and South Eastern Nigeria respectively. [2, 3] In sub-Saharan Africa, the pooled prevalence of CKD by Ajayi *et al* [4] was 17.8% (95%CI 13.0- 23.3%) with a significantly higher prevalence in West Africa (21.3% (95% CI: 16.1–27.0, $p < 0.0001$).

Among the risk factors for chronic kidney diseases are diabetes mellitus, hypertension, herbal remedies, and old age use of Non-steroidal anti-inflammatory agents (NSAIDS). [3] Diabetes and hypertension are usually top in the list of such risk factors. Obesity is also one of the risk factors associated with kidney diseases though there are divergent views on this aspect.

Chronic kidney diseases can impair the quality of lives of diabetic patients once the chronic complication sets in. Thus, it becomes necessary to evaluate the prevalence of chronic kidney disease and obesity among our diabetic patients. In a study done by Akpor *et al*, [5] among 200 randomly selected diabetic and hypertensive participants in a tertiary hospital, the prevalence of CKD were 39.8%

and 57.1% respectively. The level of awareness of CKD among the respondents was low. Adegoke *et al*, [6] in a meta- analysis reported the prevalence of diabetic kidney disease in Nigeria as 28% (95% CI = 3–58).

Obesity is another non-communicable disease which is prevalent in developed nations of the world but due to sedentary lifestyle, physical inactivity and dietary indiscretion, the metabolic disorder is gradually becoming a challenge in developing nations. Obesity is common in patients with T2DM and the former has also been shown to cause or worsen CKD though the mechanism is not so explicit. [7] The renal complications of obesity may be related to the comorbid conditions such as hypertension and diabetes. However, there seem to be evidence suggesting that higher adiposity may be associated with improved outcomes in patients with end stage renal disease. [8]

There are few literatures which have evaluated the relationship of chronic kidney disease and obesity in patients with type 2 diabetes mellitus especially in Nigeria which necessitated the study.

METHODOLOGY

Study setting: The study was carried out at Diabetes clinic of Internal Medicine Department, Alex-Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State, Nigeria.

Study design: The study design was a cross sectional study which involved 205 patients with T2DM who were on routine follow up visits.

Inclusion criteria.

1. Adults diagnosed to have T2DM within the ages of 30- 70 years
2. Adults with T2DM attending Diabetes clinic of AEFUTHA
3. T2DM patients who gave consent for the study.

Exclusion criteria

1. Adults diagnosed to have T2DM who did not consent
2. Adult T2DM patients on nephrotoxic medications

Sample size: The sample size was calculated using the formula, $N = Z^2pq/e^2$

[9] where, n= sample population, Z=1.96, p=prevalence, q=1-p, e = standard error of 0.05

P=7.0 (pooled prevalence of diabetes in Nigeria. [10]

Hence the sample size, $N = 1.96 \times 1.96 \times 0.07 \times (1-0.07) / (0.05 \times 0.05)$.

$0.25008 / 0.0025 = 100.03$. This is the minimum sample size. However, in order to increase the statistical power, the sample size was increased to 205.

Ethical consideration: The ethical approval for the study was obtained from the Research and Ethical Committee of the Alex-Ekwueme Federal University Teaching Hospital, Abakaliki with a reference number of NHREC/16/05/22/440. The patients who did not give consent were excluded from the study but were given appropriate medical care.

Study procedure: The study involved serum estimation of glomerular filtration rate using MDRD equation and obesity using BMI after obtaining informed consent from the patients.

Anthropometric measurements were carried out on the participants which involved weight (Kg), Height (m), BMI (Kg/m^2). The height and weight were measured using a stadiometer with a weighing balance (HH Hospitex Height Scale) attached. Height was measured and recorded in metres to the nearest 0.1m with the individual not putting on footwear or headgears and the feet apposed together. Weight (w) was measured in kilograms to the nearest 0.5kg with participants putting on light clothing and no shoes.

Blood pressure was measured using Accusson's sphygmomanometer with appropriate cuff size in a sitting position in the right upper arm while placing the hand at the level of the heart. The average of two separate blood pressure readings at five minutes interval was taken as the participant's blood pressure. Blood pressure ≥ 140 mmHg and ≥ 90 mmHg were regarded as systolic and diastolic blood pressures respectively. [11]

Blood samples were collected from patients to assay for the serum urea and creatinine concentrations. The chemical method used for the assay of serum creatinine and urea were Jaffe reaction and urease method respectively. [12, 13]

Study instruments

1. Interviewer administered questionnaires which were used to obtain the socio-demographic data of participants
2. Stadiometer with weighing scale (HH Hospitex Height Scale) was used to obtain weight and height of participants
3. Sphygmomanometer (Accusson's sphygmomanometer) and Littman Cardio III stethoscope with cuff circumference of 12 x 15cm.
4. Spectrophotometer (Spectrumlab 23A, model S23A22003) for serum creatinine and urea estimation.

RESULTS

General characteristics of the study participants.

The number of participants in the study was 87 males and 136 females. One hundred and forty one (64.9%) diabetic patients were above 50 years while 35% were less than 50 years. These are shown in

table 1 below. The mean age of participants was 55.25 ± 11.20 years. The mean weight and height were 71.75 ± 15.17 kg and 157 ± 21.23 cm respectively as shown in table 2. Elevated systolic, diastolic and combined systolic & diastolic blood pressures were recorded in 31.7%, 26.4% and 17.9% of the study participants respectively as shown in table 3. The mean Systolic blood pressure was 130.67 ± 21.57 while the mean diastolic blood pressure was 77.57 ± 14.97 mmHg.

Table 1: Age and sex distribution of participants

Sex and age

Variable	Freq	Percent (%)
Age		
<50	76	35.0
>50	141	64.9
Sex		
Female	136	60.9
Male	87	39.0

Table 2: Mean and standard deviation for age, weight and height

Variable	Mean ± Standard deviation
Age	55.25 ± 11.20
Weight	71.75 ± 15.17
Height	157 ± 21.23

Table 3: Blood Pressure of participants

Variable	Freq	Percent (%)
Systolic		
Normal	129	56.8
Raised	72	31.7
Diastolic		
Normal	141	62.1
Raised	60	26.4
Systolic and diastolic		
Normal	162	71.4
Raised	39	17.2

BMI categorization of participants

Among the participants, 4.8%, 25.8%, 28.8% were underweight, normal weight and overweight respectively. Obesity class 3 was obtained in 9.2% of the participants. The bar chart is shown in Figure 1. The mean BMI was $32.90 \pm 26.83 \text{ Kg/m}^2$

MDRD Categorization of participants

The MDRD stages of the diabetic patients are shown in figure 2 below. The mean eGFR $78.16 \pm 58.30 \text{ ml/min/1.73m}^2$

The significant relationship between MDRD categories and sex is shown in Table 4 with ($\chi^2=39.026$, P-value 0.000)

Table 4: Relationship between sex and MDRD(GFR)

Sex	MDRDGFR						χ^2	P-value
	G1	G2	G3A	G3B	G4	G5		
Female	15(18.3)	23(28.0)	26(31.7)	13(15.9)	3(3.7)	2(2.4)	39.026	0.000
Male	21(42.9)	17(34.7)	3(6.1)	6(12.2)	2(4.1)	0(0.0)		

The negative correlation of age and MDRD is shown in table 5.

Table 5 Correlation of Age and MDRD classes

Correlation coefficient r, p-value (n=205)		
	Age	MDRD
Age	1	r= -0.184 p= 0.035
MDRD		1

The relationship between BMI and MDRD staging is shown in table 6 and the relationship was not statistically significant (P = 0.592)

Table 6: Relationship between BMI and MDRD (GFR)

BMI	MDRDGFR						χ^2	P-value
	G1	G2	G3A	G3B	G4	G5		
Underweight	1(25.0)	1(25.0)	2(50.0)	0(0.0)	0(0.0)	0(0.0)	22.761	0.592
Normal weight	10(25.6)	13(33.3)	6(15.4)	8(20.5)	2(5.1)	0(0.0)		
Overweight	10(23.8)	10(23.8)	11(26.2)	7(16.7)	3(7.1)	1(2.4)		
Obese class 1	8(32.0)	10(40.0)	6(24.0)	1(4.0)	0(0.0)	0(0.0)		
Obese class 2	2(50.0)	0(0.0)	2(50.0)	0(0.0)	0(0.0)	0(0.0)		
Obese class 3	5(45.5)	2(18.2)	1(9.1)	2(18.2)	0(0.0)	1(9.1)		

The relationship between age and BMI is shown in Table 7. The table showed that the relationship between the 2 variables was significant.

Table 7: Relationship between age and BMI

Age	BMI						χ^2	P-value
	Underweight	Normal weight	Overweight	Obese class 1	Obese class 2	Obese class 3		
<50	5(6.8)	24(32.9)	16(21.9)	15(21.9)	6(8.2)	7(9.6)	11.725	0.039
>50	6(4.6)	34(26.0)	46(35.1)	31(23.7)	1(0.8)	13(9.9)		

The relationship between age and BMI is shown in Table 7. The table shows that the relationship between the 2 variables is significant.

DISCUSSION

Chronic kidney disease staging using MDRD formula is one of the acceptable ways of estimating glomerular filtration rate. The distribution of the participants showed that majority are within stages 1–3. Most of the participants in this study have deranged renal function using estimated GFR though majority are at the early stages. Martinez—Montoro *et al* [14] reported that among diabetic patients, 74.8% were in CKD stages 1 and 2. This emphasizes the need for adequate renal protection to delay worsening of renal dysfunction [15]

The prevalence of chronic kidney disease using egfr of ≤ 60 mls/min/1.73m² was 43.1%. Shahwan *et al* [16] reported a prevalence which is similar to the finding in the present study but Fiesha *et al* 2014 [17] reported a lower prevalence in Ethiopian study. Diabetes remain the commonest cause of CKD in Nigeria and other nations of the world. The mortality associated with diabetes-related nephropathy is worse in Nigeria and other sub-Saharan African countries. [18]

This was similar to the findings of Adem and colleagues [19] who reported a prevalence of 31.5% using CKD Epi info formula among 267 randomly selected patients with diabetes mellitus attending Dessie Referral Hospital, North East Ethiopia. The equation, CKD Epi info is reported to have a better accuracy in estimating glomerular filtration rate compared to MDRD equation. [20]

Obesity which is a common cardiovascular risk is prevalent in the study group. The prevalence of obesity using BMI was 32.8% which included Obesity Class 1, 2 and 3. This is lower than the finding of Al Jarad *et al* [21] where the prevalence of obesity among 382 diabetic patients was recorded as 46.0% with morbid obesity included. This may be due to the proportion of lean type 2 diabetic patients which accounts for 30.6% of the study participants. The pooled prevalence of overweight and obesity in a systematic study by Ekpore *et al* [22] was 35.6% and 25.6% respectively. The prevalence of obesity from the systematic study is lower than the finding from the present study which may be due to the large sample size and a better geographical spread in the former study. Obesity is a risk factor for type 2 diabetes and can coexist with hypertension and dyslipidemia to constitute metabolic syndrome. Insulin resistance is a pathogenetic link between diabetes, hypertension and obesity. [23]

Obesity measurements using BMI did not correlate significantly with MDRD stages of CKD. This is in line with the findings of some authors. [24, 25] Both were independent studies in Taiwanese and Iranian populations. The Taiwanese study was a multicentre study which involved 7357 patients with CKD and noted that obesity or overweight did not correlate significantly with CKD progression compared to normal weight. However, it's important to note that the study a general population of Taiwanese unlike the index study which is a hospital based study among diabetic patients.

Furthermore, the finding of no correlation between MDRD classes and obesity using BMI substantiates the fact that MDRD equation is non- reflection of obesity–related kidney changes. [26, 27] MDRD formula emphasizes variables such as age, sex, race and creatinine concentration.[28] The significant correlation of MDRD with sex and age effectively corroborate their reflection in the MDRD equation.

Moreover, MDRD relies mainly on serum creatinine. [29]. As the index study participants consist more of females (female,136: male, 86) where the ratio of muscle mass to total body weight is lower resulting in lower creatinine production and invariably elevated eGFR thus, removing the statistical significance between obesity classes.

In diabetic population, MDRD has been shown to underestimate eGFR especially when kidney function is relatively preserved. The participants in the present study who has CKD, stages 1 & 2 accounted for 57.6% of total population size which depict relative preserved renal function. [30] Moreover, BMI may not properly capture adiposity in CKD patients due to muscle wasting and fluid overload. This may emphasize the use of Waist circumference and Waist hip ratio as better and more accurate anthropometric measures. [31]

Despite the fact that this study does not support a significant link in this cohort, the role of BMI in kidney health remains complex and warrants further investigation. This gave rise to the obesity paradox as high BMI is shown to be implicated in new onset CKD but it is paradoxically associated with better survival outcomes in advanced CKD. [32]

Hypertension and CKD

Hypertension is a risk factor for chronic kidney disease or can be a sequeale of chronic kidney disease. A study population with a higher incidence of CKD may likely have a higher prevalence of hypertension. The prevalence of hypertension is usually higher in diabetic patients with or without chronic kidney disease. The prevalence of hypertension among the participants was 75.6% which consisted of: 31.7% for systolic hypertension only, 26.4% for diastolic hypertension only and 17.2% for both systolic and diastolic hypertension. The finding is similar to that of Naseri *et al*, [33] which reported 70.5%. However, Chowdhury *et al* [34] reported a prevalence of 31% among 138 diabetic patients. Akalu & Belts [35] in a hospital study in Ethiopia reported a prevalence of 59.5% among 378 patients with T2DM. Hypertension in patients can arise as a form of essential hypertension or as a result of diabetic complications. Insulin resistance is related to undue activation of Renin- Angiotensin Aldoosterone System (RAAS) mechanisms which increase blood pressure and give rise to hypertension. [36]

Conclusion: Chronic kidney disease is a well-defined chronic complication in T2DM patients and the prevalence is high among the participants. The risk factors for CKD include hypertension and diabetes. BMI did not correlate with MDRD staging which further confirms that the former is not incorporated as a variable in MDRD formula unlike age and sex which are key variables. Age and sex correlated significantly with MDRD classes in the study. However, the non-significant correlation of BMI and MDRD staging of CKD does not negate the effect of obesity in CKD.

Declarations

Funding: There was no funding from any donor agency

Conflict of interest: There is none to declare.

Ethical approval and consent to participate: The study was conducted according to the principles of the 2024 revision of the World Medical Association. Ethical approval for the study was obtained from the Research and Ethics Committee of AEFUTHA, with a reference number of NHREC/16/05/22/440.

Consent to participate: Informed consent in written or thumb –printed forms was obtained from each participant before recruitment.

Consent to Publication: Not applicable.

Data availability: Data will be made available upon request and will be made public in the future.

Code availability: Not applicable

Authors' contributions: Conceptualization, CVU; methodology CVA, NMU, MUU, EO, NCA validation, CVU, MUU, NMU, OFA formal analysis, CVU, EO, OFA; Original draft preparation, NMU, CVU, MU, OCA: Supervision, CVU. All authors have read and agreed to the published version of the manuscript.

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Figures

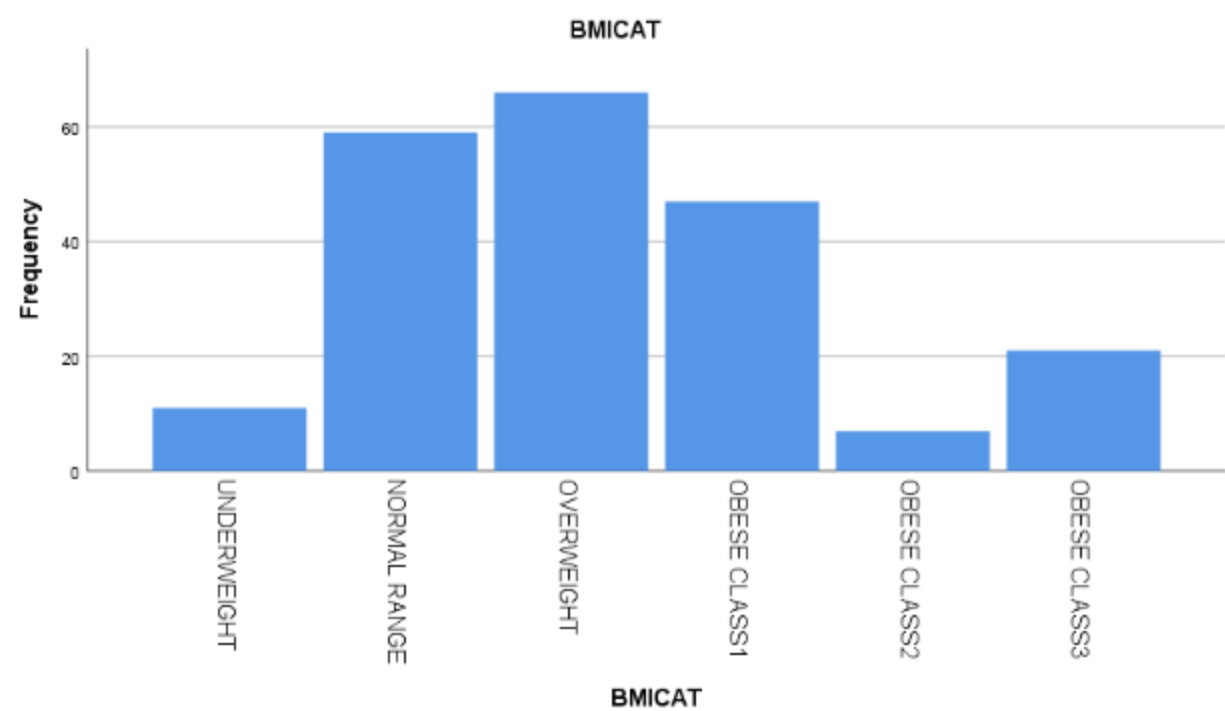


Figure 1

BMI distribution of the study participants

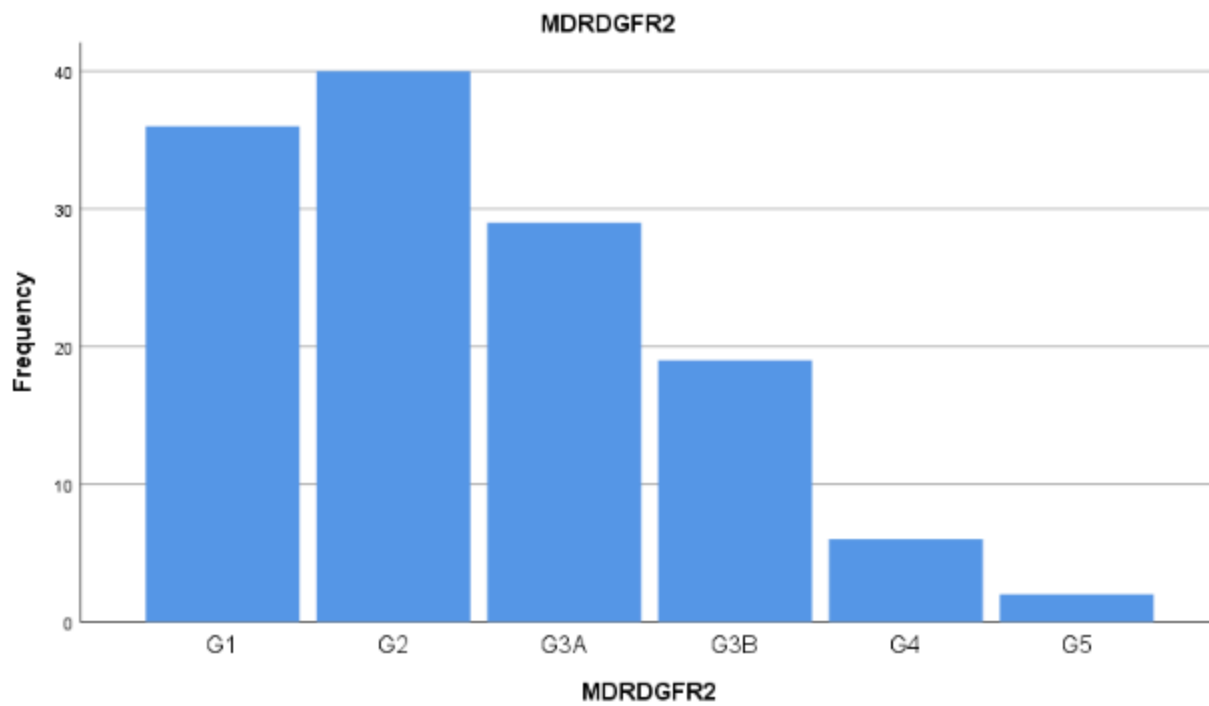


Figure 2

MDRD classes based on eGfr of participants