Original research article

Assessment of Serum Urea and Creatinine in Type 2 Diabetes Mellitus Patients: Implications for Early Detection of Renal Dysfunction

ABSTRACT

Introduction:

Type 2 diabetes mellitus (T2DM) is frequently associated with subclinical renal dysfunction, which can progress to chronic kidney disease if undetected. This study assessed serum urea and creatinine concentrations in patients with T2DM to evaluate their utility for early detection of renal dysfunction.

Method:

A comparative cross-sectional study included sex-matched participants with T2DM and non-diabetic controls. Data collected were age, educational attainment, and marital status. Serum creatinine, urea, and fasting plasma glucose (FBG) were measured. Correlation analyses evaluated associations between glycemic control and renal function.

Result:

Sex matching reduced gender-related confounding. Age differences were not statistically significant; however, most participants with diabetes were middle-aged or older. Non-diabetic participants demonstrated higher educational attainment, which may reflect the influence of health literacy on disease risk. Participants with diabetes had significantly higher creatinine and urea concentrations, consistent with early renal impairment. Fasting plasma glucose (FBG) showed a positive correlation with creatinine ($r = 0.488$; $p < 0.0001$) and urea ($r = 0.948$; $p < 0.0001$).

Conclusion:

Modest elevations in blood glucose are associated with subclinical renal dysfunction in individuals with T2DM. Regular monitoring of renal biomarkers, strict glycemic control, and interventions focused on patient education are necessary to prevent progression to chronic kidney disease, especially among middle-aged and older adults.

Key words:Type 2 diabetes, renal dysfunction, fasting glucose, creatinine, urea, education

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder. It is characterized by persistent hyperglycemia due to defects in insulin secretion, insulin action, or both (Banday et al., 2020). Insulin is a pancreatic hormone that plays a central role in glucose homeostasis. Its deficiency or resistance impairs carbohydrate metabolism. Globally, diabetes is a major public health concern. Its rising prevalence contributes greatly to morbidity and mortality (Obianyido et al., 2025).

DM is classified into two primary types. Type 1 diabetes mellitus (T1DM) was previously called insulin-dependent diabetes. Type 2 diabetes mellitus (T2DM) was formerly known as non-insulin-dependent diabetes. Additional forms result from genetic abnormalities or secondary factors, such as medication use, pancreatic disorders, or physiological changes like gestational diabetes in pregnancy. Type 2 diabetes mellitus is the most common form both globally and in Nigeria. It accounts for about 90% of all local cases. T2DM is also one of the major causes of kidney failure(Hoogeveen et al., 2025). Chronic kidney disease (CKD) affects about 50% of patients with T2DM(Siddiqui et al.,2022)

The prevalence of diabetes mellitus (DM) is increasing globally. According to the International Diabetes Federation (IDF), 537 million adults aged 20 to 79 years were diagnosed with diabetes in 2021(IDF, 2021;Hossain et al., 2024). Projections estimate that the number of cases will reach 643 million by 2030 and 783 million by 2045(Liu et al., 2025). In 2021, approximately 24 million individuals in Africa were diagnosed with diabetes. This number is projected to rise by 129 percent, reaching 55 million by 2045(Shaikhomer et al., 2025). In Nigeria, diabetes represents an escalating public health concern. Ezeani et al. (2020) reported a prevalence of 3.3% in southeastern Nigeria in 2020. More recently, Okonofua et al. (2025) documented a national prevalence of 5.5%. These findings indicate that DM is an increasingly significant endocrinological disorder in Nigeria.The primary factors contributing to this increase include population aging, urbanization, sedentary lifestyles, unhealthy dietary patterns, and higher obesity rates.

Diagnosis of DM is primarily based on blood glucose measurements. Fasting blood glucose (FBG) is assessed after an overnight fast. Random blood glucose is taken at any time. The two-hour postprandial (2HPP) test evaluates glucose levels two hours after a meal. The oral glucose tolerance test (OGTT) is a first-line assessment in clinical settings. It involves administering a standardized glucose load and monitoring plasma glucose at set intervals to assess glycemic response (Darden et al., 2020; Makriset al., 2024). Glycated hemoglobin (HbA1c) is used widely to monitor long-term glycemic control.

DM is linked to debilitating complications. These include cardiovascular disease, nephropathy, neuropathy, and retinopathy. Such complications diminish quality of life and create substantial economic burdens for individuals and healthcare systems (Almalki & Khan, 2025). Diabetic nephropathy (DN) is a leading cause of chronic kidney disease (CKD) and end-stage renal disease (ESRD). It is a major microvascular complication of longstanding diabetes (Suneja et al., 2021). DN develops gradually and is marked by distinct renal biochemical changes, such as arly hyperfiltration. Microalbuminuria, altered serum creatinine and urea levels, electrolyte imbalances, and dysregulation of biomarkers like cystatin C and neutrophil gelatinase–associated lipocalin (NGAL) are observed (Gallo et al., 2023).

Early detection of renal impairment in diabetes is critical. Clinical symptoms often do not appear until after most nephrons are lost (Alkhaqani et al., 2022). Renal biochemical markers help detect subtle functional changes before overt kidney disease develops (Mizdrak et al., 2022). These include serum creatinine, urea, estimated glomerular filtration rate (eGFR), cystatin C, and urinary albumin excretion. Microalbuminuria is the earliest known indicator of diabetic nephropathy (Thipsawa et al.,2021). Interpreting these biomarkers along with electrolyte profiles and other renal function measures enables a thorough assessment. This supports timely interventions to slow or prevent disease progression.

The increasing global prevalence of DM, combined with the frequently asymptomatic onset of renal impairment, highlights the necessity of early detection to prevent irreversible kidney complications. Effective intervention depends on regular biochemical monitoring and equitable access to healthcare services.

This study evaluates urea and creatinine levels in individuals with diabetes mellitus (DM) receiving treatment in referral hospitals in Enugu metropolis and examines their correlation with fasting plasma glucose to determine clinical relevance. Focusing on a Nigerian population, the research aims to generate context-specific evidence to inform early detection, monitoring, and intervention strategies for diabetic nephropathy. The anticipated findings will inform clinicians and policymakers in improving renal surveillance protocols and preventing diabetes-related renal complications

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MATERIALS AND METHOD

Study Area/Design

This study utilized a cross-sectional survey design conducted in Enugu, a city in southeast Nigeria situated at the base of the Udi plateau. Enugu had a population of 722,664 and an area of 556 square kilometers as of the National Population Commission (NPC, 2006). The population mainly comprises civil servants and traders (Obianyido et al., 2023). The study population consisted of patients attending the diabetic clinic at Enugu State University of Science and Technology Teaching Hospital (ESUTH), Parklane, Enugu.

Ethical Consideration

The study was reviewed and approved by the Ethical Committee of the ESUTH Teaching Hospital in Enugu (ESUTHP/C-MACRA/034/VOL.4/98). All procedures used in this study adhered to the guidelines outlined in the 1964 Declaration of Helsinki. Participant’s confidentiality was ensured.

Study Population

One hundred and sixty respondents aged 30 to 65 years, matched for age and sex, were recruited for this study. Of these, eighty participants diagnosed with diabetes were assigned to the test group, and eighty healthy non-diabetic participants were assigned to the control group. All participants met the inclusion criteria and gave written informed consent.

Eligibility criteria

Control participants were eligible if they had no history of diabetes, hypertension, or renal disease, and were not taking medications that affect renal function. and had no recent acute illnesses or chronic diseases. Case participants were required to have a confirmed diagnosis of Type 2 Diabetes Mellitus for at least one year and to be attending the diabetic clinic for routine follow-up. and were not receiving dialysis or nephroprotective therapy. All respondents provided written informed consent

Sample size determination and Sampling technique

The sample size was calculated using the formula for determining sample size in cross-sectional studies as described by Naing et al. (2022). The prevalence of Diabetes in southeast Nigeria is 3.7% (Adeloye et al., 2017). Respondents were selected by simple random sampling, every 3rd individual who gave a written informed consent was interviewed and selected

Blood sample collection and Laboratory methods

Participants were instructed to fast overnight, abstaining from all food and beverages for 10 to 12 hours following their last evening meal. Blood samples were collected the next morning. The antecubital fossa was cleaned with methylated spirit swabs, and a tourniquet was applied to aid venipuncture. A total of 4 milliliters (mL) of venous blood was collected using a sterile syringe. Of this, 1mL in a fluoride oxalate tube for fasting blood glucose measurement, and 3 mL in a plain tube for urea, and creatinine determination. The sample in the plain tube was allowed to clot, then centrifuged at 4000 revolutions per minute for 5 minutes. The separated serum was transferred to labeled containers and stored at 2 to 4 degrees Celsius. All analyses were performed within 48 hours. Fasting blood glucose level was estimated by the glucose oxidase method,serum creatinine level was assessed using the modified Jaffe method (Moore and Sharer, 2017), while urea was measured using the Diacetyl Monoxime (DAM) method (Langenfeld et al,.2021).

Statistical data analysis

Data management involved Microsoft Excel 2016, followed by export to GraphPad Prism version 8.0 (GraphPad Software Inc., USA) for statistical analysis. Normality of the data were assessed. Continuous variables were presented as mean ± standard deviation, and categorical variables as frequencies and percentages. Depending on data distribution, continuous variables were analyzed with either Student's t-test or Mann-Whitney U test, while the chi-square test assessed categorical variables. Relationship between fasting plasma glucose and renal parameters were evaluated using Pearson or Spearman correlation coefficients, as appropriate. Statistical significance was set at $p < 0.05$.

RESULTS

Table 1: Sociodemographic Characteristics of Study Participants

Parameters	Diabetics n(%)	Non -Diabetics n(%)	p-value
SEX			**<0.999**
Males	**40(50)**	**40(50)**	
Females	**40(50)**	**40(50)**	
Age(years)			**0.154**
30-39	**10(12.50)**	**13(16.25)**	
40-49	**26(13.50)**	**30(37.50)**	
50-59	**33(41.25)**	**34(42.50)**	
≥60	**11(13.75)**	**03(3.75)**	
Academic attainment			**0.042***
Completed primary School	**00(00)**	**01(1.25)**	
Completed primary School	**34(42.50)**	**48(60.00)**	
Completed primary School	**46(57.50)**	**31(38.75)**	
Relationship Status			**0.741**
Living with a partner	**27(33.75)**	**30(37.50)**	
Living without a partner	**53(66.25)**	**50(62.50)**	

Table 1; summarizes the sociodemographic characteristics of 160 participants, including 80 individuals with type 2 diabetes and 80 non-diabetic controls. Both groups exhibited identical sex distributions, with equal representation of males and females (50.0% each). No statistically significant difference in sex distribution was identified between groups ($p > 0.999$).

The majority of participants in both groups were aged 50–59 years (41.3% of diabetics and 42.5% of controls), followed by those aged 40–49 years. A higher proportion of diabetics were aged 60 years or older compared to controls (13.8% versus 3.8%). However, the overall age distribution did not differ significantly between groups (p = 0.154).

Educational attainment differed significantly between groups (p = 0.042). A higher proportion of controls completed secondary-level education (60.0%) compared to diabetics (42.5%). Conversely, a greater percentage of diabetics attained higher education (57.5%) than controls (38.8%). Only one control participant reported primary education as the highest qualification.

Most respondents in both groups were not living with a partner (66.3% of diabetics and 62.5% of controls). No statistically significant difference in marital status was observed between groups (p = 0.741).

Table 2: Comparison of the biochemical parameters of the study participants

Parameters	Diabetics	Non-diabetics	p-value
Fasting Plasma glucose(mgdl)	113.7.40±15.78	78.57±10.33	<0.0001***
Creatinine (mg/L)	1.40±0.34	0.83±0.18	<0.0001***
Urea (mmol/L)	7.79±1.78	4.03±0.53	<0.0001***

Table 2; compares fasting plasma glucose and renal function markers in diabetic and non-diabetic participants. Fasting plasma glucose was significantly higher in the diabetic group (109.40 ± 15.78 mg/dL) than in non-diabetic controls (78.57 ± 10.33 mg/dL), with a highly significant difference ($p < 0.0001$).

Serum creatinine levels were markedly elevated in diabetic participants (1.40 ± 0.34 mg/L) compared to non-diabetic participants (0.83 ± 0.18 mg/L), indicating impaired renal function ($p < 0.0001$). Mean serum urea concentration was also more than double in the diabetic group (7.79 ± 1.78 mmol/L) compared to controls (4.03 ± 0.53 mmol/L), with a statistically significant difference ($p < 0.0001$).

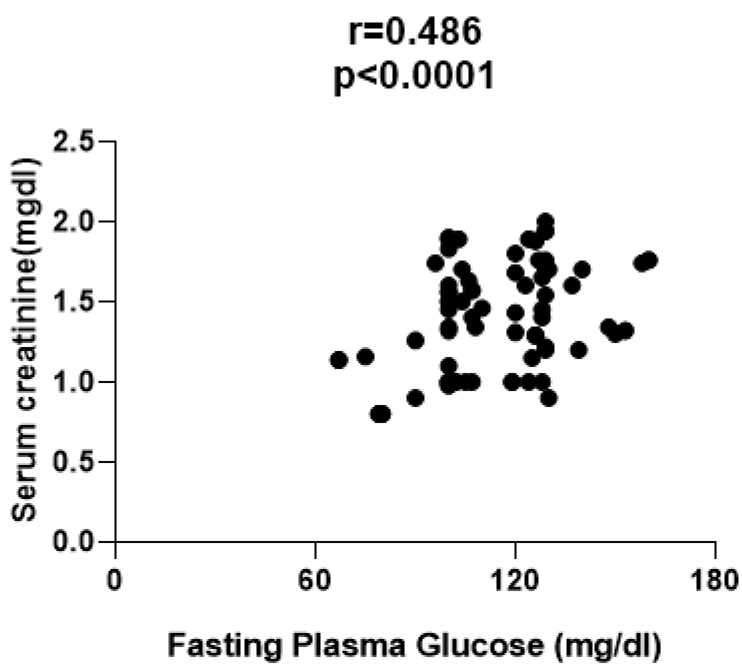

Fig1. Correlation Between Fasting Plasma Glucose and Serum Creatinine

A significant positive correlation($r = 0.486$, $p < 0.0001$) was observed between fasting plasma glucose and serum creatinine levels among diabetic participants, as illustrated in Figure 1.

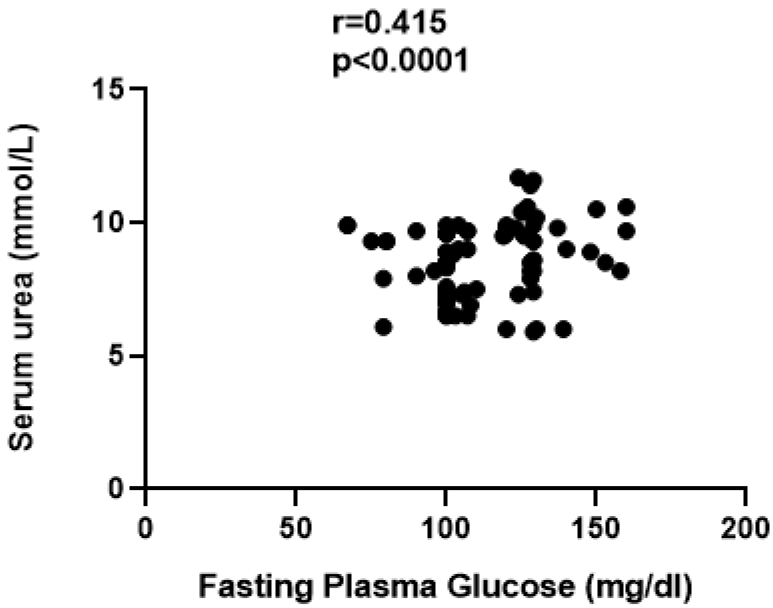

Fig2. Correlation Between Fasting Plasma Glucose and Serum urea

A significant positive correlation ($r = 0.415$, $p < 0.0001$) was observed between fasting plasma glucose and serum urea levels among diabetic participants, as illustrated in Figure 2.

DISCUSSION

This study evaluates serum urea and creatinine concentrations in individuals diagnosed with type 2 diabetes mellitus who are receiving care at referral hospitals in Enugu metropolis. The investigation also examines the correlation between these renal biomarkers and fasting plasma glucose to clarify their clinical relevance. Fasting plasma glucose concentrations were significantly higher in the diabetic cohort compared to non-diabetic controls. This observation is consistent with previous findings. Persistent hyperglycemia accelerates renal injury through several biochemical mechanisms. Elevated glucose levels facilitate the formation and accumulation of advanced glycation end products (AGEs). These contribute to both structural and functional deterioration of renal tissue (Wu et al., 2023). Four principal pathogenic pathways are implicated in hyperglycemia-induced diabetic nephropathy. They include activation of the polyol pathway, the hexosamine biosynthetic pathway, increased AGE formation, and protein kinase C (PKC) activation (Pirola et al.,2010). These mechanisms disrupt cellular homeostasis, increase oxidative stress, and promote glomerular sclerosis. This underscores the central role of chronic hyperglycemia in the development and progression of diabetic renal complications.

Diabetic participants exhibited significantly higher creatinine and urea levels compared to non-diabetic controls. These results are consistent with previous studies (Bamanik et al.,2016; Liu et al.,202; Ullah et al.,2023; Akpotaire et al., 2023). Hyperglycemia induces renal hyperfiltration, which directly leads to both microvascular and macrovascular alterations. These vascular changes, in turn, cause an elevated glomerular filtration rate (GFR), resulting in increased serum urea and creatinine concentrations (Ceriket al., 2023). This underscores the well-documented phenomenon that diabetic nephropathy often progresses subclinically before overt symptoms emerge (Podadera-Herreros et al.,). In settings with limited resources, where advanced markers such as microalbuminuria are not routinely available, serum urea and creatinine serve as practical and cost-effective screening tools. Routine biochemical monitoring may facilitate early intervention and reduce the risk of progression to chronic kidney disease or end-stage renal failure.

Positive correlations between fasting plasma glucose and serum creatinine demonstrate that poor glycemic control is closely associated with declining renal function in individuals with type 2 diabetes. This observation is consistent with previous research (Bamanika et al., 2016, Liu et al., 2022, Ullah et al., 2023 Akpotaire et al., 2023). Collectively, these findings indicate that elevated blood glucose levels may initiate renal dysfunction prior to the clinical manifestation of kidney disease.

The sociodemographic characteristics of the study population indicate that diabetic and non-diabetic groups were comparable in sex distribution, minimizing potential gender-related bias in the comparative analysis. While age differences were not statistically significant, most individuals with diabetes were middle-aged or older adults, supporting the established association between aging and type 2 diabetes (Nanayakkara et al.,2021). A significant difference in educational attainment was observed, with non-diabetic participants more frequently completing secondary education. This finding implies that higher educational levels may provide protective benefits through increased health literacy and engagement in preventive behaviors (Almachavan, 2024). Relationship status did not differ significantly between groups. However, the high proportion of participants not cohabiting with a partner in both groups may indicate limited social support, which could affect long-term disease management. These results highlight the need to incorporate targeted health education and age-specific renal screening into diabetes care programs.

CONCLUSION

Elevated serum creatinine and urea levels in type 2 diabetic patients, along with their positive correlation with fasting plasma glucose (FPG), suggest a higher chance of subclinical renal dysfunction. Sociodemographic factors, particularly lower educational attainment, may exacerbate disease progression by limiting health awareness and preventive behaviors. Regular monitoring of renal biomarkers, strict glycemic control, and targeted education interventions are essential to prevent progression to chronic kidney disease in middle-aged and older diabetic patients.

CONSENT

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s)

DECLARATION OF INTEREST

None to declare

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