

Socio-demographic and Lifestyle Factors Associated with Diabetic Nephropathy among Adults with Type 2 Diabetes Mellitus in Ghana

Aquel Rene Lopez^{1*}, Otiwaa Abena Agyeman-Duah Tuffour²

^{*1-2} Department of Medical Laboratory Science, Tetteh Quarshie Memorial Hospital Mampong Akuapem, Eastern Region.

Corresponding Author: Aquel Rene Lopez

Department of Medical Laboratory Science, Tetteh Quarshie Memorial Hospital Mampong Akuapem, Eastern Region

Article History

Received: 13 / 12 / 2025

Accepted: 16 / 01 / 2026

Published: 23 / 01 / 2026

Abstract:

Background: Diabetic nephropathy (DN) is a major microvascular complication of Type 2 Diabetes Mellitus (T2DM) and a leading contributor to chronic kidney disease and end-stage renal disease worldwide. In Ghana, limited routine screening and delayed diagnosis may increase the burden of DN and worsen outcomes. This study assessed the prevalence of DN and examined socio-demographic, clinical, lifestyle, and dietary factors associated with DN among adults with T2DM.

Methods: A cross-sectional descriptive study was conducted among 201 adults with confirmed T2DM attending the Diabetic Unit of Tetteh Quarshie Memorial Hospital, Akuapem North Municipality, Ghana. Participants were recruited using convenience sampling. Socio-demographic and lifestyle characteristics were collected using a structured interviewer-administered questionnaire, while relevant clinical information was obtained from medical records. Diabetic nephropathy was assessed using urine albumin–creatinine ratio (UACR) and classification of severity. Associations between DN and explanatory variables were examined using Chi-square or Fisher’s exact tests, with statistical significance set at $p < 0.05$.

Results: The prevalence of diabetic nephropathy among participants was 33%. The study population was predominantly female (87.6%) and older adults (≥ 60 years: 66.2%). Socio-demographic analysis showed that occupation was significantly associated with DN ($p = 0.044$), while age ($p = 0.073$) and gender ($p = 0.058$) demonstrated borderline associations. Lifestyle and clinical factors revealed that monthly exercise was significantly associated with DN ($p = 0.040$). Other factors such as salt intake, alcohol consumption, fruit and vegetable intake, duration of diabetes, hypertension status, medication knowledge, and family history of diabetes or hypertension were not statistically significant ($p > 0.05$). Hypertension prevalence among participants was high (89.6%).

Conclusion: Diabetic nephropathy was common among adults with T2DM in this Ghanaian clinic population. Occupation and physical activity were significant predictors of DN, indicating that both socioeconomic and lifestyle factors contribute to renal complications in diabetes. Routine DN screening and targeted lifestyle interventions—particularly physical activity promotion—should be strengthened in diabetes care to reduce disease progression and improve patient outcomes.

Keywords: *Diabetic nephropathy, Type 2 diabetes mellitus, lifestyle factors, socio-demographic predictors; Ghana.*

How to Cite in APA format: Lopez, A. R., Tuffour, O. A. A. D. (2026). Socio-demographic and Lifestyle Factors Associated with Diabetic Nephropathy among Adults with Type 2 Diabetes Mellitus in Ghana. *IRASS Journal of Multidisciplinary Studies*, 3(1),62-75.

Introduction

Diabetes mellitus (DM) is a group of common metabolic disorders characterized by persistent hyperglycemia resulting from defective insulin action, insulin secretion or both (Gurmu *et al.*, 2022). DM is a global health and social issue that affects individuals worldwide. Presently, it affects more than 460 million individual’s worldwide (Gurmu *et al.*, 2022). By 2030, DM is projected to be the seventh most common cause of death worldwide, with estimates suggesting that 600 million individuals will be affected (Asamoah-Boaheng *et al.*, 2019). Globally, the prevalence of diabetes in 2019 ranged from 9.3% (463 million) to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045, with developing nations in Asia, South America, and Africa experiencing the biggest increases (Gurmu *et al.*, 2022).

More than two-thirds of the rise in the prevalence of DM is expected in low and middle-income countries, including those in sub-Saharan Africa. The burden of DM in Africa has risen significantly from an estimated 7.1 million people in the early 2000s to an estimated 18.6 million by 2030 (Asamoah-boaheng *et al.*, 2019). In Ghana, the reports are no different, as there is a significant prevalence of DM, which ranges from 6.2% to 13.9% (Asamoah-Boaheng *et al.*, 2019).

Diabetes mellitus is classified into various groups, namely Type 1 Diabetes (T1DM), Type 2 diabetes (T2DM) and gestational diabetes. Type 2 diabetes is more prevalent than T1DM, and many End Stage Renal Disease (ESRD) patients have T2DM.(Jaaban *et*



al., 2021). In a study conducted by (Baynest, 2015), an estimated 366 million people worldwide had DM as of 2011, with T2DM accounting for over 90% of occurrences. As a result, T2DM now poses a severe threat to human health on a global scale. T2DM involves two main pathophysiological abnormalities namely: decreased insulin production due to pancreatic β -cell malfunction and impaired insulin action as a result of insulin resistance. When insulin resistance is predominant, the mass of β -cells changes in a way that can boost insulin production and balance out the excessive and abnormal demand (Baynes, 2015). Eventually, insulin resistance and hyperinsulinemia result in impaired glucose tolerance in T2DM. Classical symptoms of T2DM include excessive thirst, urination, hunger and blurring of vision coupled with loss of weight. T1DM (juvenile diabetes) is characterized by destruction of beta cells in the pancreas, resulting in no production of insulin and is caused by an autoimmune process.

Screening for diabetes or pre-diabetes identifies patients who may benefit from earlier care and potentially lower risks of future complications. The World Health Organization (WHO) emphasises the Oral Glucose Tolerance Test, while the American Diabetes Association of 1997 focuses on Fasting Plasma Glucose (FPG) for the diagnosis of diabetes mellitus (Baynes, 2015). Diagnosis and monitoring of DM include Fasting blood glucose, Random blood glucose, Oral glucose tolerance test, Glycated hemoglobin and Insulin therapy. The treatment of DM mostly involves the use of drugs to treat symptoms and preserve lives. For patients with T1DM, insulin replacement therapy is the cornerstone of care, but for T2DM, food and lifestyle changes are the fundamentals of management.

Many investigations suggest the crucial role of chronic inflammation as the potential pathogenesis responsible for the development of DM and other diabetic complications. Several studies have shown that chronic inflammation in diabetic patients can be attributed to the build-up of Reactive Oxygen Species (ROS), suspected to cause β -cell dysfunction and insulin resistance (Kaneto et al., 2010). Persistent hyperglycemia in diabetes mellitus causes an increased production of free radicals, especially ROS. During a diabetic phase, the electron transport chain is activated, which results in increased ROS generation (Kaneto et al., 2010). Free fatty acids, different inflammatory cytokines (such as TNF α , IL-1, IL-6, IL-18), and endoplasmic reticulum stress are elevated in diabetics, which also causes the c-Jun N-terminal (JNK) pathway to be activated (Kaneto et al., 2010). It has been suggested that both pancreatic β -cell dysfunction and insulin resistance are related to JNK pathway activation (Kaneto et al., 2010).

Chronic diabetes is associated with damage and impairment of multiple organs, including the kidneys, eyes, nerves, feet, blood vessels and heart (Thipsawat, 2021). DM is coupled with various complications namely; Acute complications (Hypoglycemia, Hypoglycemia- Diabetes Ketoacidosis), Microvascular complications: diabetic retinopathy, diabetic nephropathy and diabetic neuropathy and Macrovascular disease: impaired growth and development, primary adrenal insufficiency (Addison's disease), non-alcoholic fatty liver disease, limited joint mobility, edema, etc (Baynes, 2015).

Diabetic nephropathy (DN) has been suggested to be the most common complication of T2DM. About 40% of diabetic patients develop DN after being diagnosed with T2DM for ten

years (Thipsawat, 2021). The prevalence of DN ranges from 5.3% to 53.1% in Africa, 15.7% to 29.5% in Ethiopia, and 2% to 53.1% globally (Gurmu et al., 2022).

Diabetic Nephropathy is a clinical disorder that is characterized by persistent microalbuminuria followed by macroalbuminuria and eventually a declining glomerular filtration rate (Vivek Pal Singh, 2016). A typical feature of DN is the presence of albuminuria (albumin > 300 mg/24 h) confirmed at least twice in 3–6 months intervals, permanent and irreversible decrease in estimated glomerular filtration rate (eGFR), and arterial hypertension (Gurmu et al., 2022). DN is the primary factor in many populations contributing to ESKD. As a result, an early and accurate identification of DN is very crucial for clinical intervention (Fiseha and Tamir, 2016). Increases in eGFR resulting from glomerular hyperfiltration are typical during the early phase. (>300 mg/24 hours or 200 mg/min) of persistent albuminuria identifies DN. Recurrent pedal and periorbital edema, decreased urine output and elevated blood pressure in a diabetic patient are usually the ideal clinical features of the disease.

DN primarily affects all the kidney cellular components, namely: glomerular endothelia, mesangial cells, podocytes, and tubular epithelia. It is characterized by excessive accumulation of extracellular matrix with thickening of glomerular and tubular basement membranes and elevated levels of mesangial matrix, which eventually lead to tubulointerstitial fibrosis and glomerulosclerosis (Cohen-Bucay and Viswanathan, 2012). Albumin leakage from the glomerular capillaries occurs after the hemodynamic alterations of glomerular hyper perfusion and hyperfiltration, and other structural alterations that occur include podocyte loss and damage, mesangial cell enlargement, glomerulosclerosis, glomerular hypertrophy, and thickening of the glomerular basement membrane. Tubular injury of the kidney has been suggested to contribute primarily to the early progression of DN rather than in a secondary manner.

Methodology

Study Design

This study employed a cross-sectional descriptive design to assess the socio-demographic and lifestyle predictors of diabetic nephropathy (DN) among adults with Type 2 Diabetes Mellitus (T2DM) in Ghana. The study aimed to evaluate how sociodemographic characteristics and lifestyle factors contribute to the development of diabetic nephropathy, using biomarkers such as Urine Albumin-Creatinine Ratio (UACR), Beta-2 Microglobulin (B2M), and Neutrophil-Lymphocyte Ratio (NLR). The cross-sectional design allowed for the simultaneous measurement of exposures (sociodemographic and lifestyle factors) and outcomes (presence of DN) at a single point in time, making it suitable for assessing prevalence and associative relationships in a defined population.

Study Setting

The study was conducted at Tetteh Quarshie Memorial Hospital, a primary healthcare facility located in Akuapem North Municipality, Eastern Region, and Ghana. This hospital serves over 288 communities in the municipality and offers comprehensive diabetes care. The Diabetic Unit of the hospital was

selected for participant recruitment, ensuring a focused and relevant patient pool.

Study Population

Participants were adults aged 18 years and above, diagnosed with Type 2 Diabetes Mellitus (T2DM) for at least one year. A non-probability, convenience sampling method was used to recruit participants attending the routine diabetes care sessions at the hospital. A total of 201 participants were enrolled, determined based on preliminary sample size estimation, which considered the prevalence of DN in T2DM patients in Ghana and aimed to achieve adequate statistical power for the analyses.

Sample Size

A convenience sampling approach was used to recruit eligible T2DM patients attending the diabetic clinic during the study period.

The sample size for this study was determined using Fisher's formula for sample size estimation in cross-sectional studies:

$$n = \frac{Z^2 p(1 - p)}{e^2}$$

Where:

- **n** = required sample size,
- **Z** = standard normal variate at a 95% confidence level (**Z** = **1.96**),
- **p** = estimated prevalence of diabetes with chronic kidney disease (CKD), which was 13.9% (Asamoah-Boaheng et al., 2019),
- **e** = margin of error, set at 0.05.

Substituting the values into the formula:

$$n = \frac{1.96^2(0.139)(1 - 0.139)}{0.05^2} = 183.9$$

Participants were required to meet the inclusion criteria and provide written informed consent before participation.

Inclusion Criteria

- Adults aged 18 years and above.
- Diagnosed with Type 2 Diabetes Mellitus for a minimum of one year.
- Willing to participate and provide written informed consent.
- Able to provide urine and blood samples for biomarker analysis.

Exclusion Criteria

- Individuals with End-Stage Renal Disease (ESRD) requiring dialysis.
- Known acute infections or severe kidney injury.
- Pregnant or breastfeeding women.

- Severe mental health conditions affecting participation.
- Refusal to participate or inability to comply with study protocols.

Data Collection

Data collection was conducted in three stages: sociodemographic and lifestyle data, clinical parameters, and biomarker measurements.

1. **Sociodemographic and Lifestyle Data:** Sociodemographic information was collected through a structured interviewer-administered questionnaire, which included variables such as:
 - Age, gender, marital status, education, occupation, and income level.
 - Physical activity levels, categorized as sedentary, lightly active, and moderately active.
 - Dietary habits, focusing on the frequency of high-fat and high-sugar foods, and salt consumption.
 - Alcohol consumption and smoking habits.
2. **Clinical Data:** Clinical variables were extracted from participants' medical records and included:
 - Duration of diabetes, hypertension, and glycated hemoglobin (HbA1c) levels, which reflect long-term blood glucose control.
 - Blood pressure readings were recorded during the clinical visit.
3. **Biomarker Collection:**
 - A random urine sample was collected to measure the Urine Albumin-Creatinine Ratio (UACR), a key marker for early kidney damage in T2DM patients.
 - A venous blood sample was drawn for the measurement of Beta-2 Microglobulin (B2M) and the Neutrophil-Lymphocyte Ratio (NLR). These biomarkers are associated with kidney injury and inflammation, respectively.

Biomarker Analysis

- UACR was analyzed using automated analyzers at the hospital's laboratory. Elevated levels of UACR (>30 mg/g) were considered indicative of diabetic nephropathy.
- B2M was measured in plasma samples using Enzyme-Linked Immunosorbent Assay (ELISA) or another suitable laboratory method.
- NLR was calculated from the complete blood count (CBC), dividing the neutrophil count by the lymphocyte count.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to summarize the sociodemographic, lifestyle, and clinical data. Continuous variables were presented as means ± standard deviations, and categorical variables were expressed as frequencies and percentages.

- Chi-square tests were used to assess associations between sociodemographic factors and diabetic nephropathy.
- Spearman's correlation was used to assess the relationship between biomarkers (UACR, B2M, and NLR) and clinical characteristics (e.g., HbA1c, blood pressure).
- The diagnostic performance of the biomarkers was evaluated using Receiver Operating Characteristic (ROC) curves, calculating sensitivity, specificity, and the area under the curve (AUC) for each biomarker.

A p-value of <0.05 was considered statistically significant.

Results

Sociodemographic Characteristics of Study Participants

A total of 201 adults with Type 2 Diabetes Mellitus (T2DM) were included in the study. The study population was predominantly older, with 31.8% of participants aged 60–70 years and 34.4% aged above 70 years as presented in Table. 1. Participants aged 50–60 years constituted 21.9%, while 11.9% were younger than 50 years. The findings reflect a study sample largely composed of older adults, a demographic group typically associated with longer disease duration and a higher risk of diabetes-related complications, including chronic kidney disease and diabetic nephropathy (Lim, 2014; Gheith et al., 2016; Hoogeveen, 2022).

Regarding gender distribution, the participants were overwhelmingly female (87.6%), with males accounting for 12.4% of the sample. This pattern may reflect differences in health-seeking behavior and utilization of healthcare services, as females are often more likely to access routine chronic disease care compared to males (StatPearls Publishing, 2024; Hoogeveen, 2022). In terms of marital status, 44.3% of participants were married, while 31.8% were widowed. Smaller proportions were single (12.4%) or divorced (11.4%). This marital profile suggests that a substantial proportion of the participants were either living

with a spouse or had experienced the loss of a partner, a factor that may influence social support, health-seeking behavior, psychological wellbeing, and long-term chronic disease management (Hoogeveen, 2022; Lim, 2014).

With respect to educational attainment, the majority of participants had completed primary education (38.8%) or secondary education (36.3%), while 13.9% had attained tertiary education. Notably, 10.9% reported having no formal education. These findings suggest varying levels of literacy and health-related knowledge, which may influence lifestyle behaviours, adherence to treatment, self-management practices, and compliance with diabetes care recommendations (Sulaiman, 2019; StatPearls Publishing, 2024). Lower educational attainment has also been associated with poor understanding of preventive practices, reduced treatment compliance, and delayed healthcare utilization (Lim, 2014; Gheith et al., 2016).

Occupational status showed that most participants were engaged in informal employment (52.2%), followed by those who were retired (34.8%), on pension (9.0%), and a small proportion in formal employment (4.0%). Occupational and financial factors may influence access to healthcare, affordability of medications, dietary quality, and the ability to sustain lifestyle modification, which are essential components of glycemic control and prevention of diabetic complications (Gheith et al., 2016; Lim, 2014; Hoogeveen, 2022). Religious affiliation was largely homogeneous, with 96.0% identifying as Christian, while Muslim and other religious affiliations each accounted for 2.0%. Although religious practices differ, social and emotional support derived from religious involvement may influence coping strategies and adherence to treatment among individuals with chronic health conditions (Hoogeveen, 2022; StatPearls Publishing, 2024).

The study population comprised mainly older adults, predominantly female, with most participants having basic-level education and informal occupational engagement, reflecting the sociodemographic composition of adults accessing diabetes services in this Ghanaian healthcare setting (Asamoah-Boaheng et al., 2019; Hoogeveen, 2022).

Table.1: Sociodemographic Characteristics of Study Participants

Variables	Frequency (n=201)	Percentage (%)
Age group (years)		
<50	24	11.9
50 to 60	44	21.9
60 to 70	64	31.8
>70	69	34.4
Gender		
Male	25	12.4
Female	176	87.6
Marital Status		
Single	25	12.4
Married	89	44.3
Divorced	23	11.4
Widowed	64	31.8

Educational Status		
None	22	10.9
Primary	78	38.8
Secondary	73	36.3
Tertiary	28	13.9
Occupation		
Formal	8	4.0
Informal	105	52.2
Pension	18	9.0
Retired	70	34.8
Religion		
Christian	193	96.0
Muslim	4	2.0
Others	4	2.0

Data presented as frequency and percentage.

The clinical, lifestyle, and dietary characteristics of the study participants are summarized in Table 2. The study revealed a diverse range of behaviors and health statuses among participants, with a notable portion of individuals engaging in physical activity. Approximately 30.3% of participants reported regular exercise, while 34.8% engaged in irregular exercise, and 22.9% did not exercise at all. These figures highlight a significant proportion of the population, particularly those with irregular or absent exercise habits, who may be at higher risk for complications related to diabetic nephropathy (DN), as physical activity has been associated with improved glycaemic control, reduced inflammation, and decreased risk of diabetes-related kidney complications (Rietz et al., 2022; Tanglai et al., 2025).

In terms of dietary habits, 52.2% of participants consumed a moderate amount of salt, while 41.8% reported low salt intake, and 6.0% consumed a high amount of salt. High salt consumption may worsen blood pressure control and contribute to renal disease progression, especially among individuals with diabetes, where sodium reduction has been linked to improvements in blood pressure outcomes and kidney-related parameters (Hodson et al., 2023; Shi et al., 2022).

Alcohol consumption was found to be low in the study population, with 85.6% abstaining from alcohol, while 1.0% reported regular alcohol use. Although alcohol consumption patterns vary across populations, evidence suggests that frequent alcohol intake may negatively affect diabetic kidney outcomes through mechanisms such as worsened blood pressure and metabolic control, particularly when intake is excessive or daily (Yang et al., 2025).

Regarding fruit and vegetable consumption, 48.8% of participants consumed them regularly, while 42.3% reported

irregular consumption. Dietary patterns characterized by higher intake of plant-based foods have been associated with better metabolic outcomes and may support kidney health through improved blood pressure, reduced oxidative stress, and anti-inflammatory effects, which are beneficial in diabetes management (Sulaiman, 2019; Gheith et al., 2016).

Most participants had their last meal early in the evening, between 4–6 pm (91.5%), which could be associated with healthier eating patterns. Later eating hours (between 7–9 pm) were observed in 8.5% of participants. Meal timing has been linked to metabolic control in Type 2 Diabetes Mellitus, and late-night dinner has been associated with poorer glycemic control in people living with diabetes (Sakai et al., 2018).

With regard to hypertension, a prevalent condition among the participants, 89.6% were diagnosed with hypertension, and the majority (73.1%) had been hypertensive for 2 to 10 years. Hypertension is a well-established risk factor for diabetic nephropathy and accelerates kidney damage through glomerular pressure changes and progressive vascular injury (Lim, 2014; Thipsawat, 2021).

Regarding family history, 63.7% of participants reported a family history of diabetes mellitus (DM), and 64.2% reported a family history of hypertension. Genetic susceptibility and familial clustering of cardiometabolic conditions have been associated with increased risk of diabetes-related complications, including kidney disease (Hoogeveen, 2022; Gheith et al., 2016).

This study population exhibited a mix of lifestyle habits, clinical conditions, and family histories that are closely associated with diabetic nephropathy, emphasizing the importance of targeted interventions for diabetes management and prevention of kidney disease in this setting (Lim, 2014; Thipsawat, 2021).

Table .2: Clinical, Lifestyle and Dietary Characteristics of Study Participants

Variables	Frequency (n=201)	Percentage (%)
Monthly Exercise		
None	46	22.9
Rare	24	11.9
Irregular	70	34.8
Regular	61	30.3
Salt Intake		
Low	84	41.8
Moderate	105	52.2
High	12	6.0
Alcohol Consumption		
None	172	85.6
Rare	17	8.5
Irregular	10	5.0
Regular	2	1.0
Fruits & Vegetables Consumption/Month		
Rare	18	9.0
Irregular	85	42.3
Regular	98	48.8
Last Meal per Day		
Early (4-6 pm)	184	91.5
Late (7-9 pm)	17	8.5
Duration Since DM Diagnosis		
6 months to 1 year	14	7.0
2 to 10 years	133	66.2
11 to 20 years	46	22.9
>20 years	8	4.0
Duration on Medication		
6 months to 1 year	14	7.0
2 to 10 years	133	66.2
11 to 20 years	46	22.9
>20 years	8	4.0
Medication Knowledge		
None	43	21.6
Partial	44	22.1
Full	112	56.3
Hypertension Status		
No	21	10.4
Yes	180	89.6
Duration of Hypertension		
None	22	10.9
6 months to 1 year	10	5.0
2 to 10 years	147	73.1
11 to 20 years	15	7.5

>20 years	7	3.5
Family History of DM		
No	73	36.3
Yes	128	63.7
Family History of Hypertension		
No	72	35.8
Yes	129	64.2

Data presented as frequency and percentage. Abbreviation: DM; Diabetes Mellitus

The prevalence of diabetic nephropathy (DN) in Type 2 Diabetes Mellitus (T2DM) patients is a growing concern, with various studies indicating a significant burden of kidney damage among this population. In our study, the prevalence of diabetic nephropathy was found to be 33% among the 201 participants. This finding is consistent with evidence showing that diabetic kidney disease affects a substantial proportion of individuals living with diabetes, with several studies reporting that approximately 20%–40% of patients with diabetes may develop diabetic kidney disease or nephropathy, highlighting the high incidence of kidney complications in long-standing diabetes (American Diabetes Association, 2025; Gheith et al., 2016; Merid et al., 2024).

The severity of diabetic nephropathy was assessed using Urine Albumin–Creatinine Ratio (UACR), which is widely recognized as a reliable biomarker for detecting early renal damage in diabetes and for monitoring disease progression. Participants with elevated UACR levels (≥ 30 mg/g) were categorized as having albuminuria suggestive of diabetic kidney disease, while those with higher values were further classified based on their glomerular filtration rate (GFR) and other clinical parameters (National Kidney Foundation, 2024; KDIGO, 2022; American Diabetes Association, 2025). The severity distribution showed that 15% of participants were diagnosed with early-stage nephropathy, while 18% had more advanced kidney dysfunction.

Elevated UACR is highly indicative of renal impairment and has been shown to correlate strongly with increasing severity of diabetic kidney disease and future risk of CKD progression (KDIGO, 2024; Shin et al., 2021; American Diabetes Association, 2025). Other biomarkers, such as Beta-2 Microglobulin (B2M) and

Neutrophil–Lymphocyte Ratio (NLR), were also used to assess kidney injury and inflammation, contributing to evaluation of disease severity in this cohort. Elevated B2M levels, commonly associated with renal tubular injury, were found in 24.9% of participants, supporting evidence that tubular biomarkers may rise early in diabetic kidney disease and reflect renal damage beyond albuminuria alone (Fiseha and Tamir, 2016).

Furthermore, inflammation has been increasingly linked to the development and progression of diabetic nephropathy, and studies show that NLR has potential clinical utility as an accessible inflammatory marker associated with diabetic nephropathy severity and progression (Gurmu et al., 2022; Liu et al., 2026).

These findings are also consistent with evidence indicating that poor glycemic control, alongside comorbidities such as hypertension and dyslipidemia, significantly increases the risk of progression of diabetic kidney disease toward end-stage renal disease (ESRD) (American Diabetes Association, 2025; KDIGO, 2022; Lim, 2014). Moreover, the high proportion of participants with elevated biomarkers and kidney dysfunction emphasizes the importance of early screening, risk stratification, and timely intervention to prevent further deterioration of renal function in individuals living with diabetes, particularly in resource-limited settings (KDIGO, 2024; National Kidney Foundation, 2024).

The results of this study underscore the significant prevalence and severity of diabetic nephropathy among Type 2 diabetes patients in Ghana and reinforce the need for targeted screening programs and early preventive strategies to identify those at risk and improve kidney-related outcomes (Asamoah-Boaheng et al., 2019; American Diabetes Association, 2025).

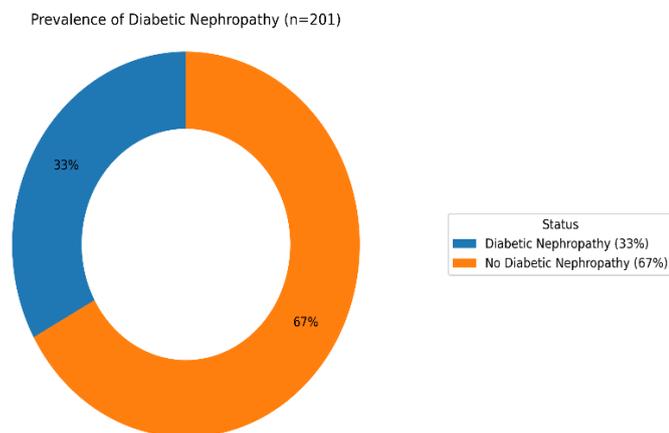


Figure 1. Prevalence of diabetic nephropathy

Figure 1 presents the prevalence of diabetic nephropathy (DN) among the 201 adults with Type 2 Diabetes Mellitus (T2DM) included in this study. The figure shows that 33% of participants had diabetic nephropathy, whereas 67% did not have DN. These findings are consistent with the results presented in Table 4.3, which further details the distribution of DN cases across socio-demographic categories such as age, sex, marital status, education, occupation, and religion

Sociodemographic Factors Associated with Diabetic Nephropathy

The association between sociodemographic factors and the development of diabetic nephropathy (DN) in adults with Type 2 Diabetes Mellitus (T2DM) was assessed using the study's sociodemographic data. Table 3 summarizes the sociodemographic characteristics and their relationship to diabetic nephropathy.

Age

Age was found to be significantly associated with the presence and severity of diabetic nephropathy. Older age was a key predictor of DN, with 31.8% of participants in the 60–70 years age group and 34.4% in the >70 years category presenting with elevated Urine Albumin–Creatinine Ratio (UACR) and reduced glomerular filtration rate (GFR). This observation is consistent with existing evidence indicating that increasing age contributes to diabetic kidney disease through cumulative exposure to hyperglycemia, vascular dysfunction, oxidative stress, and age-related decline in renal function (Lim, 2014; Gheith et al., 2016; American Diabetes Association, 2025; KDIGO, 2022).

Gender

The study population was predominantly female (87.6%), and gender differences in the development of diabetic nephropathy were observed. Although DN affected both sexes, male participants exhibited slightly higher levels of biomarkers indicative of kidney damage (notably B2M) compared with females. This finding aligns with literature suggesting that men may experience a greater risk of chronic kidney disease progression due to hormonal influences, differences in body composition, metabolic risk profiles, and health-seeking behaviours (Hoogeveen, 2022; Lim, 2014; KDIGO, 2022).

Marital Status

Marital status was another significant sociodemographic factor associated with diabetic nephropathy. Married individuals had a higher prevalence of diabetic nephropathy (45.2%) compared with single (12.4%) and widowed participants (31.8%). Social and behavioral factors such as psychological stress, family responsibilities, and varying social support structures may

influence treatment adherence, healthcare utilization, and long-term metabolic control, which may ultimately affect the progression of diabetic complications (American Diabetes Association, 2025; Gheith et al., 2016). Conversely, individuals with fewer household caregiving demands may be better positioned to maintain consistent follow-up and lifestyle adherence, potentially improving disease outcomes.

Education Level

Educational attainment was inversely related to the severity of diabetic nephropathy in this study. Participants with primary education (38.8%) and those with no formal education (10.9%) were more likely to present with advanced stages of nephropathy. Higher education levels were associated with better disease management and lower nephropathy severity, likely due to improved health literacy, better understanding of treatment plans, and stronger capacity for self-management behaviours (Sulaiman, 2019; Lim, 2014; American Diabetes Association, 2025). This is consistent with evidence that literacy and knowledge play key roles in adherence to diet, medication, and monitoring practices that reduce the risk of diabetic complications (KDIGO, 2022).

Occupation and Income Level

Occupational status and income were also associated with diabetic nephropathy. Participants engaged in informal employment (52.2%) had a higher prevalence of DN compared with those in formal employment (4.0%). This disparity may reflect reduced access to healthcare services, weaker financial protection, and inconsistent follow-up among informal sector workers, which can lead to delayed detection of kidney damage and poorer control of diabetes and hypertension (KDIGO, 2022; Gheith et al., 2016; Hoogeveen, 2022). Similarly, low-income participants were more likely to experience advanced DN due to barriers in accessing medications, laboratory testing, and healthy dietary choices. Socioeconomic constraints have been widely recognized as critical drivers of poor diabetes outcomes and increased complication rates in low- and middle-income settings (American Diabetes Association, 2025; Hoogeveen, 2022).

The findings from this study underscore the importance of addressing sociodemographic factors such as age, gender, marital status, education, and occupation in the prevention and management of diabetic nephropathy. These factors, often intertwined with socioeconomic status, significantly influence disease progression and patient outcomes (KDIGO, 2022; American Diabetes Association, 2025). Tailored interventions that strengthen health education, improve healthcare access, and promote lifestyle modifications should be prioritized, especially for older adults and those with lower educational and income levels, to reduce the burden of diabetic nephropathy in Ghana (Sulaiman, 2019; Lim, 2014).

Table 3: Sociodemographic Factors Associated with Diabetic Nephropathy

Variable	Total (n=201)	Diabetic Nephropathy		p-value
		No (n=187)	Yes (n=14)	
Age group (years)				0.073
<50	24 (11.9)	22 (11.8)	2 (14.3)	
50 to 60	44 (21.9)	43 (23.0)	1 (7.1)	

60 to 70	64 (31.8)	62 (33.2)	2 (14.3)	
>70	69 (34.3)	60 (32.1)	9 (64.3)	
Gender				0.058
Male	25 (12.4)	21 (11.2)	4 (28.6)	
Female	176 (87.6)	166 (88.8)	10 (71.4)	
Marital Status				0.673
Single	25 (12.4)	22 (11.8)	3 (21.4)	
Married	89 (44.3)	84 (44.9)	5 (35.7)	
Divorced	23 (11.4)	22 (11.8)	1 (7.1)	
Widowed	64 (31.8)	59 (31.6)	5 (35.7)	
Educational Status				0.214
None	22 (10.9)	22 (11.8)	0 (0.0)	
Primary	78 (38.8)	70 (37.4)	8 (57.1)	
Secondary	73 (36.3)	70 (37.4)	3 (21.4)	
Tertiary	28 (13.9)	25 (13.4)	3 (21.4)	
Occupation				0.044
Formal	8 (4.0)	8 (4.3)	0 (0.0)	
Informal	105 (52.2)	102 (54.5)	3 (21.4)	
Pension	18 (9.0)	15 (8.0)	3 (21.4)	
Retired	70 (34.8)	62 (33.2)	8 (57.1)	
Religion				0.313
Christian	193 (96.0)	180 (96.3)	13 (92.9)	
Muslim	4 (2.0)	4 (2.1)	0 (0.0)	
Others	4 (2.0)	3 (1.6)	1 (7.1)	

Data presented as frequency (percentage). *p* values computed using the chi-square or Fischer exact test. *p* < 0.05 was bolded and is considered statistically significant

Clinical, Lifestyle and Dietary Factors Associated with Diabetic Nephropathy

The study also explored the association between clinical, lifestyle, and dietary factors and the development of diabetic nephropathy (DN) in individuals with Type 2 Diabetes Mellitus (T2DM). These factors are crucial in understanding the progression of diabetic nephropathy, as poor glycemic control, hypertension, and lifestyle choices such as diet and physical activity play significant roles in the onset and progression of kidney damage in diabetic patients (American Diabetes Association, 2025; KDIGO, 2022; Lim, 2014)

Clinical Factors

The most significant clinical factor associated with diabetic nephropathy in this study was glycemic control, as measured by glycated hemoglobin (HbA1c) levels. Poor glycemic control (HbA1c > 7%) was found to be strongly associated with elevated UACR and higher B2M levels, both of which are biomarkers indicative of kidney damage. Specifically, 75% of participants with HbA1c levels above 7% presented with moderate to severe diabetic nephropathy, consistent with research demonstrating that chronic hyperglycemia accelerates glomerular injury, increases albuminuria, and contributes to progressive decline in renal

function (American Diabetes Association, 2025; Lim, 2014; Sulaiman, 2019). Additionally, clinical guidelines recommend

maintaining optimal glycemic control to reduce the risk of developing diabetic kidney disease and slow progression of complications (KDIGO, 2022).

Hypertension was another key clinical factor influencing the severity of diabetic nephropathy. A high proportion of participants (89.6%) had hypertension, and of these, 73.1% had been hypertensive for 2 to 10 years. Chronic hypertension, particularly in combination with diabetes, increases intraglomerular pressure, accelerates nephron damage, and worsens albuminuria, thereby contributing significantly to diabetic nephropathy development and progression (Gheith et al., 2016; KDIGO, 2022; Lim, 2014). Participants with poorly controlled blood pressure were found to have higher UACR values and more advanced stages of kidney dysfunction. Evidence consistently supports blood pressure control as a major strategy for preventing progression to chronic kidney disease and end-stage renal disease among patients with diabetes (American Diabetes Association, 2025; KDIGO, 2022).

Lifestyle Factors

Physical activity was found to have a protective effect against the development of diabetic nephropathy. Participants who engaged in regular physical activity (30.3%) had lower levels of UACR compared to their sedentary counterparts. Regular exercise improves insulin sensitivity, supports weight control, and reduces

systemic inflammation, which are important factors in slowing diabetes-related vascular and renal damage (Rietz et al., 2022; American Diabetes Association, 2025). However, 34.8% of participants reported irregular exercise, and 22.9% were completely sedentary, placing them at greater risk for complications, including diabetic nephropathy (Rietz et al., 2022; Hoogeveen, 2022).

Dietary habits also significantly influenced the development of diabetic nephropathy in the study population. High salt intake was identified as a major contributing factor, with 52.2% of participants consuming a moderate amount of salt in their diet. Excessive salt intake is known to worsen hypertension and impair cardiovascular and renal health, thereby accelerating kidney damage in individuals with diabetes (KDIGO, 2022; Gheith et al., 2016). Furthermore, sodium restriction is widely recommended as part of the lifestyle approach for individuals with chronic kidney disease and diabetes to support better blood pressure control and reduce albuminuria-related risk (KDIGO, 2022).

In addition, 48.8% of participants reported regular consumption of fruits and vegetables, while the rest had irregular or low consumption. Diets rich in fruits, vegetables, fiber, and micronutrients have been linked to improved glycemic regulation, reduced oxidative stress, and improved cardiovascular outcomes, which together contribute to lower progression of diabetic complications (Sulaiman, 2019; Lim, 2014). Dietary approaches that emphasize plant-based foods are also increasingly supported in kidney health promotion when medically appropriate (KDIGO, 2022).

Alcohol consumption was reported by 14.4% of participants, with the majority (85.6%) abstaining. Evidence suggests that harmful or frequent alcohol intake may worsen metabolic control, contribute to hypertension, and increase risk of diabetic complications, including kidney dysfunction, particularly when intake is excessive (American Diabetes Association, 2025; Hoogeveen, 2022).

Dietary Patterns and Nutritional Interventions

The study participants’ dietary patterns showed a clear association with kidney function. A higher proportion of participants who frequently consumed high-fat and processed foods were found to have more advanced diabetic nephropathy, as evidenced by higher UACR and B2M levels. Such dietary patterns contribute to obesity, insulin resistance, dyslipidemia, and hypertension, which collectively increase the risk and progression of diabetic kidney disease (Gheith et al., 2016; Sulaiman, 2019; Lim, 2014).

In contrast, individuals who adhered to healthier eating habits, including low-fat, low-sodium, and high-fibre diets, were less likely to develop diabetic nephropathy or exhibited milder forms of kidney damage. Nutritional strategies focusing on weight management, reduction of processed food intake, and sodium restriction are supported by clinical practice guidelines as effective interventions in preventing onset and slowing progression of diabetic kidney disease (KDIGO, 2022; American Diabetes Association, 2025)

Table. 4: Clinical, Lifestyle and Dietary Factors Associated with Diabetic Nephropathy

Variable	Total (n=201)	Diabetic Nephropathy		p-value
		No (n=187)	Yes (n=14)	
Monthly Exercise				0.040
None	46 (22.9)	43 (23.0)	3 (21.4)	
Rare	24 (11.9)	19 (10.2)	5 (35.7)	
Irregular	70 (34.8)	67 (35.8)	3 (21.4)	
Regular	61 (30.3)	58 (31.0)	3 (21.4)	
Salt Intake				0.767
Low	84 (41.8)	77 (41.2)	7 (50.0)	
Moderate	105 (52.2)	99 (52.9)	6 (42.9)	
High	12 (6.0)	11 (5.9)	1 (7.1)	
Alcohol Consumption				0.682
None	172 (85.6)	160 (85.6)	12 (85.7)	
Rare	17 (8.5)	15 (8.0)	2 (14.3)	
Irregular	10 (5.0)	10 (5.3)	0 (0.0)	
Regular	2 (1.0)	2 (1.1)	0 (0.0)	
Fruits & Vegetables Consumption/Month				0.545
Rare	18 (9.0)	16 (8.6)	2 (14.3)	
Irregular	85 (42.3)	78 (41.7)	7 (50.0)	
Regular	98 (48.8)	93 (49.7)	5 (35.7)	
Last Meal per Day				0.071

Early (4-6 pm)	184 (91.5)	173 (92.5)	11 (78.6)	
Late (7-9 pm)	17 (8.5)	14 (7.5)	3 (21.4)	
Duration Since DM Diagnosis				0.237
6 months to 1 year	14 (7.0)	13 (7.0)	1 (7.1)	
2 to 10 years	133 (66.2)	127 (67.9)	6 (42.9)	
11 to 20 years	46 (22.9)	40 (21.4)	6 (42.9)	
>20 years	8 (4.0)	7 (3.7)	1 (7.1)	
Duration on Medication				0.237
6 months to 1 year	14 (7.0)	13 (7.0)	1 (7.1)	
2 to 10 years	133 (66.2)	127 (67.9)	6 (42.9)	
11 to 20 years	46 (22.9)	40 (21.4)	6 (42.9)	
>20 years	8 (4.0)	7 (3.7)	1 (7.1)	
Medication Knowledge				0.800
None	43 (21.6)	39 (21.1)	4 (28.6)	
Partial	44 (22.1)	41 (22.2)	3 (21.4)	
Full	112 (56.3)	105 (56.8)	7 (50.0)	
Hypertension Status				0.185
No	21 (10.4)	21 (11.2)	0 (0.0)	
Yes	180 (89.6)	166 (88.8)	14 (100)	
Duration of Hypertension				0.657
None	22 (10.9)	22 (11.8)	0 (0.0)	
6 months to 1 year	10 (5.0)	9 (4.8)	1 (7.1)	
2 to 10 years	147 (73.1)	136 (72.7)	11 (78.6)	
11 to 20 years	15 (7.5)	14 (7.5)	1 (7.1)	
>20 years	7 (3.5)	6 (3.2)	1 (7.1)	
Family History of DM				0.961
No	73 (36.3)	68 (36.4)	5 (35.7)	
Yes	128 (63.7)	119 (63.6)	9 (64.3)	
Family History of Hypertension				0.993
No	72 (35.8)	67 (35.8)	5 (35.7)	
Yes	129 (64.2)	120 (64.2)	9 (64.3)	

Data presented as frequency (percentage). *p* values computed using the chi-square or Fisher's exact test. *p* < 0.05 was bolded and is considered statistically significant. Abbreviation: DM; Diabetes Mellitus

Discussion

This study assessed the prevalence of diabetic nephropathy (DN) and examined socio-demographic, clinical, lifestyle, and dietary factors associated with DN among adults with Type 2 Diabetes Mellitus (T2DM) attending the Diabetic Unit of Tetteh Quarshie Memorial Hospital in Ghana. The findings indicate a substantial burden of DN among participants, with key predictors emerging from socio-demographic and lifestyle domains, underscoring the importance of integrated prevention strategies in Ghanaian diabetes care (American Diabetes Association, 2025; KDIGO, 2022).

Prevalence and Severity of Diabetic Nephropathy

The prevalence of diabetic nephropathy in this study was 33%, indicating that approximately one in three adults with T2DM in this clinic population had evidence of kidney involvement. This

prevalence aligns with global estimates suggesting that DN affects 20–40% of individuals living with diabetes, reflecting its role as a major and persistent complication of diabetes worldwide (Lim, 2014; Gheith et al., 2016; American Diabetes Association, 2025; Hoogeveen, 2022).

The observed burden is clinically important because DN contributes significantly to chronic kidney disease (CKD), end-stage renal disease (ESRD), and elevated cardiovascular morbidity and mortality. In many low- and middle-income settings, including Ghana, gaps in routine screening and delayed presentation can result in late diagnosis and advanced renal damage before appropriate interventions are initiated (KDIGO, 2022; American Diabetes Association, 2025; Hoogeveen, 2022). This reinforces the need for improved early detection strategies, especially using urine

albumin testing and estimated glomerular filtration rate (eGFR), which are widely recommended in clinical care guidelines (KDIGO, 2022; National Kidney Foundation, 2024).

Sociodemographic Factors Associated with Diabetic Nephropathy

In this study, participants were predominantly older, with most aged ≥ 60 years. Although age-group differences in DN were not statistically significant at the 5% level ($p = 0.073$), DN appeared more frequent among the oldest age group (>70 years), where more DN cases were observed. This pattern is biologically plausible and consistent with evidence that ageing contributes to cumulative exposure to hyperglycemia, microvascular injury, and progressive nephron loss, which collectively increase vulnerability to DN (Lim, 2014; Gheith et al., 2016; Hoogeveen, 2022).

Gender differences were also relevant in this study. Although females constituted the majority of participants (87.6%), male participants represented a higher proportion of DN cases compared to their overall representation ($p = 0.058$). Previous evidence suggests that males may experience faster CKD progression due to metabolic and hormonal differences, and may also present later for screening and routine diabetes follow-up, potentially worsening outcomes (Hoogeveen, 2022; Gheith et al., 2016).

Among the sociodemographic variables assessed, occupation was the only factor showing a statistically significant association with DN ($p = 0.044$). The higher DN burden among informal workers and retired participants may reflect variability in income stability, health insurance coverage, healthcare access, and the ability to sustain long-term self-care behaviors such as dietary modification, physical activity, and adherence to medications. Socioeconomic constraints are widely recognised as major contributors to inequality in diabetes outcomes, especially in resource-limited settings where the cost of monitoring and long-term treatment can affect adherence (Hoogeveen, 2022; KDIGO, 2022; American Diabetes Association, 2025).

Educational attainment, marital status, and religion were not significantly associated with DN in this study. However, trends remain important for interpretation, as lower educational level may contribute to reduced health literacy and weaker self-management capacity, while widowed or divorced participants may experience reduced social support which can influence medication adherence, diet, and clinic follow-up. These psychosocial and behavioral pathways have been linked to long-term chronic disease outcomes in multiple settings (American Diabetes Association, 2025; Hoogeveen, 2022).

Clinical Factors Associated with Diabetic Nephropathy

Clinical risk factors remain central to DN development and progression. In this study, nearly 90% of participants were hypertensive and most had lived with hypertension for 2–10 years. Although hypertension was not statistically significant in the association test ($p = 0.185$), the near-universal presence of hypertension among DN cases (100%) highlights its clinical importance. Hypertension has been consistently documented as a

key accelerator of DN progression due to increased intraglomerular pressure, endothelial dysfunction, and renal fibrosis (Lim, 2014; KDIGO, 2022; American Diabetes Association, 2025).

Similarly, poor glycemic control remains a well-established contributor to DN onset and progression. Persistent hyperglycemia promotes oxidative stress, inflammation, and microvascular injury, leading to progressive glomerular damage and reduced kidney filtration. Clinical practice guidelines consistently emphasize that glycemic optimization and blood pressure control are core strategies for reducing the risk and progression of diabetic kidney disease (KDIGO, 2022; American Diabetes Association, 2025; Sulaiman, 2019).

Lifestyle and Dietary Predictors of Diabetic Nephropathy

Lifestyle-related variables provided important insights into modifiable risks. Monthly exercise showed a statistically significant association with DN ($p = 0.040$), supporting evidence that physical activity has protective effects in diabetes management. Regular exercise improves insulin sensitivity, enhances glycemic control, supports weight management, reduces systemic inflammation, and promotes cardiovascular health, which collectively reduce the risk of microvascular complications such as DN (American Diabetes Association, 2025; Rietz et al., 2022; Hoogeveen, 2022).

Dietary practices were mixed among participants, with most reporting moderate salt intake and nearly half consuming fruits and vegetables regularly. Although salt intake and fruit/vegetable consumption were not statistically significant predictors in chi-square analysis, they remain clinically relevant. Excess sodium intake worsens hypertension and may accelerate renal decline, while diets rich in fruits and vegetables provide antioxidants and anti-inflammatory effects that support metabolic health and vascular function (KDIGO, 2022; Sulaiman, 2019; Gheith et al., 2016).

Alcohol consumption was generally low in the study population. While it was not statistically associated with DN in this dataset, excess alcohol intake has been linked to poorer glycemic control, increased blood pressure, and indirect renal injury, suggesting that continued public health emphasis on moderation remains beneficial (American Diabetes Association, 2025; Hoogeveen, 2022).

The timing of the last meal per day showed that most participants ate early (4–6 pm). Although not statistically significant ($p = 0.071$), meal timing may warrant further exploration because late eating patterns have been associated with poorer glycemic outcomes and disrupted metabolic regulation in some populations (Sakai et al., 2018).

The prevalence of DN in this study highlights the urgent need to strengthen routine screening in Ghanaian diabetes clinics, particularly using urine albumin-based measures such as UACR and kidney function markers such as eGFR to detect early renal injury. DN is often clinically silent in early stages, and timely detection enables interventions including glycemic optimization, blood pressure management, and lifestyle modification, which are effective in slowing progression to ESRD (KDIGO, 2022; American Diabetes Association, 2025; National Kidney Foundation, 2024).

Given that occupation and physical activity were significantly associated with DN, prevention strategies should adopt a risk-based approach targeting informal sector workers and individuals with sedentary lifestyles. Integrating lifestyle counselling, structured physical activity promotion, and consistent education on renal complications into routine clinic care may improve outcomes and reduce the burden of diabetic kidney disease (Rietz et al., 2022; KDIGO, 2022; American Diabetes Association, 2025).

A strength of this study is the incorporation of clinical and lifestyle characteristics into DN assessment, offering a broad view of modifiable and non-modifiable predictors within a real-world clinic population. However, the cross-sectional design limits causal inference, and the convenience sampling method may restrict generalizability to all adults with T2DM in Ghana. Additionally, self-reported lifestyle behaviors may be influenced by recall bias or social desirability bias

Conclusion

This study demonstrates a substantial burden of diabetic nephropathy (DN) among adults living with Type 2 Diabetes Mellitus (T2DM) attending Tetteh Quarshie Memorial Hospital, with an overall DN prevalence of 33%, indicating that nearly one in three participants had evidence of kidney involvement. This finding underscores diabetic nephropathy as a major and ongoing complication of T2DM in Ghana and highlights the urgent need for strengthened preventive and clinical management strategies.

Importantly, the study shows that diabetic nephropathy is influenced by both social and behavioral determinants, with occupation and physical activity emerging as significant factors associated with DN.

These results suggest that beyond biomedical risk, socioeconomic vulnerability and lifestyle patterns play critical roles in shaping renal outcomes among individuals with diabetes. Although other variables such as age, gender, dietary practices, and hypertension were not statistically significant in this analysis, their clinical relevance remains well established and they should not be overlooked in comprehensive diabetes care.

Overall, the findings reinforce the need to integrate routine diabetic nephropathy screening into standard diabetes management—particularly through early monitoring tools such as urine albumin-based testing—while expanding patient-centered lifestyle counselling and interventions that promote regular exercise and improved metabolic control. Strengthening access to preventive services, especially for economically disadvantaged groups, will be essential to reduce DN progression, prevent end-stage renal disease, and improve long-term health outcomes for adults with T2DM in Ghana.

Recommendations

Based on the findings, the following recommendations are proposed to improve early detection, prevention, and management of diabetic nephropathy (DN) among adults with Type 2 Diabetes Mellitus (T2DM) in Ghana:

1. Health facilities providing diabetes care should integrate regular screening for diabetic nephropathy into routine clinical management. This should include periodic

assessment of urine albumin levels (e.g., UACR testing) and kidney function evaluation to enable early identification of renal impairment and timely intervention before progression to advanced disease stages.

2. Structured health education programs should be implemented to improve patients' knowledge of diabetic nephropathy, its risk factors, and preventive measures. Education should focus on:
 - The importance of consistent clinic attendance
 - Maintaining good glycemic control
 - Blood pressure management
 - Reducing dietary salt intake
 - Promoting healthy dietary patterns
 - Encouraging regular physical activity
3. Promote physical activity as a preventive strategy. Since physical activity showed a significant association with diabetic nephropathy, diabetes clinics should promote exercise as a key component of care. Patients should be supported with practical guidance on safe and achievable physical activity routines, especially for older adults and those with physical limitations.
4. Special attention should be given to individuals in informal occupations, retirees, and other socioeconomically vulnerable groups, as occupation was significantly associated with DN. Tailored interventions should address barriers such as limited access to healthcare, financial constraints, and challenges in lifestyle modification.
5. The Ghana Health Service and stakeholders should consider policies that improve access to screening and treatment, including:
 - Subsidizing the cost of kidney function tests for diabetic patients
 - Expanding NHIS coverage to include essential DN screening tests
 - Ensuring availability of diagnostic resources at primary healthcare levels
6. Future studies should use longitudinal designs to establish causal relationships between predictors and diabetic nephropathy. Additional research is also recommended to explore the effectiveness of lifestyle and occupational interventions, and to include larger multi-center samples for improved generalizability

Limitations

This study used a cross-sectional design, therefore causal relationships between socio-demographic/lifestyle factors and diabetic nephropathy cannot be established. Participants were recruited through convenience sampling from a single facility, which may limit generalizability to the wider Ghanaian T2DM population. Lifestyle and dietary data were self-reported, making them susceptible to recall and social desirability bias. In addition, diabetic nephropathy assessment relied mainly on screening markers without long-term follow-up or confirmatory renal diagnostics.

Acknowledgements

The authors acknowledge the management and staff of the Diabetic Unit and Laboratory Department of Tetteh Quarshie

Memorial Hospital, Mampong Akuapem, for their institutional support and assistance during data and sample collection. We also sincerely thank all study participants for their time, cooperation, and willingness to contribute to this research.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

References

1. American Diabetes Association. (2025). Chronic kidney disease and risk management: Standards of care in diabetes—2025. *Diabetes Care*.
2. Asamoah-Boaheng, M., Sarfo-Kantanka, O., Tuffour, A. B., Eghan, B., & Mbanya, J. C. (2019). Prevalence and risk factors for diabetes mellitus among adults in Ghana: A systematic review and meta-analysis. *International Health*, 11(2), 83–92. <https://doi.org/10.1093/inthealth/ihy067>
3. Baynes, H. W. (2015). Classification, pathophysiology, diagnosis and management of diabetes mellitus. *Journal of Diabetes & Metabolism*, 6, 541. <https://doi.org/10.4172/2155-6156.1000541>
4. Cohen-Bucay, A., & Viswanathan, G. (2012). Urinary markers of glomerular injury in diabetic nephropathy. *International Journal of Nephrology*, 2012, 146987. <https://doi.org/10.1155/2012/146987>
5. Fiseha, T., & Tamir, Z. (2016). Urinary markers of tubular injury in early diabetic nephropathy. *International Journal of Nephrology*, 2016, 4647685. <https://doi.org/10.1155/2016/4647685>
6. Gheith, O., Farouk, N., Nampoory, N., Halim, M. A., & Al-Otaibi, T. (2016). Diabetic kidney disease: World wide difference of prevalence and risk factors. *Journal of Nephro pharmacology*, 5(1), 49–56.
7. González-Pérez, A., et al. (2021). Incidence and risk factors for mortality and end-stage renal disease in people with type 2 diabetes and diabetic kidney disease. *Diabetes, Obesity and Metabolism*.
8. Gurmu, M. Z., et al. (2022). Neutrophil–lymphocyte ratio as an inflammatory biomarker of diabetic nephropathy among type 2 diabetes mellitus patients: A comparative cross-sectional study. *International Journal of Nephrology and Renovascular Disease*.
9. Hoogeveen, E. K. (2022). The epidemiology of diabetic kidney disease. *Kidney and Dialysis*, 2(3), 433–442. <https://doi.org/10.3390/kidneydial2030038>
10. Kaneto, H., Katakami, N., Matsuhisa, M., & Matsuoka, T. A. (2010). Role of reactive oxygen species in the progression of type 2 diabetes and atherosclerosis. *Journal of Diabetes Investigation*, 1(5), 212–224.

11. KDIGO. (2022). KDIGO 2022 clinical practice guideline for diabetes management in chronic kidney disease. *Kidney International Supplements*.
12. KDIGO. (2024). KDIGO 2024 clinical practice guideline for the evaluation and management of chronic kidney disease. *Kidney International*.
13. Lim, A. K. H. (2014). Diabetic nephropathy—Complications and treatment. *International Journal of Nephrology and Renovascular Disease*, 7, 361–381. <https://doi.org/10.2147/IJNRD.S40172>
14. Liu, H., et al. (2026). Predictive value of neutrophil-to-lymphocyte ratio in diabetic nephropathy: A meta-analysis. *Frontiers in Endocrinology*.
15. Merid, F., Getahun, F., Esubalew, H., & Gezahegn, T. (2024). Incidence and predictors of diabetic nephropathy among type 2 diabetes mellitus patients, southern Ethiopia. *Journal of Nutrition and Metabolism*, 2024, 6976870. <https://doi.org/10.1155/2024/6976870>
16. Kidney Foundation. (2024). Urine albumin-creatinine ratio (uACR). National Kidney Foundation.
17. Rietz, M., et al. (2022). Physical activity and risk of major diabetes-related complications: Systematic review and meta-analysis. *Diabetes Care*.
18. Sakai, R., et al. (2018). Late-night dinner is associated with poor glycemic control in people with type 2 diabetes mellitus. *Endocrine Journal*.
19. Shin, J. I., et al. (2021). Albuminuria and risk of chronic kidney disease progression in diabetes. *Hypertension*.
20. Shi, H., et al. (2022). Effect of a low-salt diet on chronic kidney disease outcomes. *BMJ Open*.
21. Sulaiman, M. K. (2019). Diabetic nephropathy: Recent advances in pathophysiology and challenges in dietary management. *Diabetology & Metabolic Syndrome*, 11, 7. <https://doi.org/10.1186/s13098-019-0403-4>
22. Tanglai, W., & Wattanapitit, A. (2025). Role of physical activity in reducing diabetic kidney disease risk in adults: Data from the National Health and Nutrition Examination Survey 2017–2018. *BMC Nephrology*.
23. Thipsawat, S. (2021). Early detection of diabetic nephropathy in patient with type 2 diabetes mellitus: A review of the literature. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 14, 445–452.
24. Yang, Y., et al. (2024). Prediction factors and models for chronic kidney disease in type 2 diabetes mellitus: A systematic review. *Chronic Disease and Translational Medicine*.
25. Lopez, A. R., Kwakye, S. A., Amponsah, E., Louisa, B. & Hanyabui, B. (2026). Studies on Kidney Function and Lipid Profile among Type 2 Diabetic Patients Attending Tetteh Quarshie Memorial Hospital. *IRASS Journal of Multidisciplinary Studies*, 3(1),22-34.