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Determinants of Diabetic Nephropathy in Patients with Type 2 Diabetes in Northern Cameroon

Astasselbe Abba Hadja Inna[1*], Moustapha Hindja[1], Moussa Oumarou[1], Almamy Aboubakar Djalloh[1], Amadou Ibrahima[2], Ali Abas[1], Paulette Djeugoue[1], Gotingar Alamine Rhamadane[3], Balkissou Adamou Dodo[1], Ba Hamadou[4]

[1]Department of Medicine and Traditional Pharmacopeia, Faculty of Medicine and Biomedical Sciences, University of Garoua, Garoua, Cameroon
[2]Department of Physiological Sciences and Biochemistry, Faculty of Medicine and Biomedical Sciences, University of Garoua, Garoua, Cameroon
[3]Department of Radiology and Medical Imaging, Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Yaounde, Cameroon
[4]Department of Internal Medicine and Specialties, Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Yaounde, Cameroon
Email: *hadjainna@yahoo.fr

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Abstract

Background: Diabetic Nephropathy (DN) is the leading cause of End-Stage Renal Disease (ESRD) globally. This study aimed to identify determinants of DN in patients with Type 2 Diabetes (T2D) in northern Cameroon. **Methods:** We conducted an analytical cross-sectional study from December 2, 2024, to May 31, 2025, among outpatients with T2D at Garoua General Hospital and the Regional Hospitals of Garoua and Maroua. Patients who provided oral consent were included, while those with other causes of nephropathy or proteinuria were excluded. DN was defined as albuminuria (micro or macro) and/or an eGFR ≤ 60 mL/min in the presence of microvascular complications (diabetic retinopathy or neuropathy). Determinants of DN were identified using logistic regression, with significance set at $p < 0.05$. **Results:** A total of 327 patients were included, with a median age (IQR) of 54 (46 - 62) years; 55.4% were men. The median duration of diabetes (IQR) was 4.6 (2.7 - 10) years, and 89.3% had an HbA1c > 7%. Physical inactivity was the most common cardiovascular risk factor (66.1%). The overall prevalence of DN was 24.5% (95% CI: 19.9 - 29.5); macroalbuminuria: 5.5%, microalbuminuria: 17.8%, and eGFR ≤ 60 mL/min in the presence of microvascular complications: 1.2%. Determinants of DN [adjusted OR (95% CI), p] were age ≥ 60 years [10.33 (4.27 - 25.00),

p = 0.004], diabetes duration ≥ 10 years [2.45 (1.02 - 6.03), p = 0.041], diabetic retinopathy [9.52 (3.14 - 28.83), p < 0.001], and diabetic neuropathy [41.35 (4.32 - 95.13), p < 0.001]. **Conclusion:** The high prevalence of DN and its determinants in our study highlights the importance of early screening and regular monitoring of patients.

Keywords

Diabetic Nephropathy, Type 2 Diabetes, Determinants, Cameroon

1. Introduction

Diabetes mellitus is a group of metabolic disorders characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both [1]. Diabetes is increasingly affecting populations worldwide and is a leading cause of premature death, particularly in low-income countries [2]. It represents the most common endocrinopathy globally and constitutes a major public health concern [3]. The incidence and prevalence of diabetes have risen significantly in recent years, largely driven by the increasing number of patients with Type 2 Diabetes (T2D) [4] [5]. In 2024, according to the International Diabetes Federation, 589 million people worldwide were living with diabetes, including 25 million in Africa [6]. In Cameroon, 2.5 million people were affected in 2023, according to data from the Ministry of Public Health [7].

Beyond acute complications such as hyperglycemia and infections, poor diabetes control exposes patients to long-term chronic complications, including Diabetic Nephropathy (DN) [5]. DN is a kidney disease characterized by persistent albuminuria, progressive decline in Glomerular Filtration Rate (GFR), and elevated blood pressure [8]. It is a common and serious complication of Type 2 Diabetes (T2D), representing the leading cause of End-Stage Renal Disease (ESRD) worldwide and the third most frequent cause of chronic kidney disease in Africa after hypertension and glomerulonephritis [9] [10].

A study conducted in 2012 by K. Griani *et al.* reported a prevalence of DN of 54% in the United States and 49% in Germany [11]. In Tunisia, Abdesselem H. *et al.* reported a prevalence of 35% in 2015 [12]. In Tchad, Ibrahim *et al.* found a prevalence of 29.83% in 2016, and in Niger, Sy *et al.* reported 38.9% in March 2020 [13] [14]. In Cameroon, the prevalence of DN was 14.2% in a 2017 study by Nelsy *et al.* in the Southwest region and 34.6% in Bamenda according to Marie E. *et al.*, with major associated factors including poor glycemic control (HbA1c > 7%), hypertension, and body mass index > 25 kg/m^2 [8] [10].

Diabetic nephropathy is associated with increased morbidity and mortality, reduced quality of life, and a substantial financial burden on healthcare systems [9]. Identifying the factors associated with DN is therefore essential for its prevention and management.

However, little data are available from the northern regions of Cameroon, particularly regarding factors specific to this population. This study, therefore, aimed to fill this gap by assessing the prevalence of diabetic nephropathy and its determinants at Garoua General Hospital and the Regional Hospitals of Garoua and Maroua.

2. Methodology

2.1. Study Design and Population

This was an analytical cross-sectional study conducted over six months, from December 2, 2024, to May 31, 2025, in the diabetes units of Garoua General Hospital (GGH) and the Regional Hospitals of Garoua (GRH) and Maroua (MRH). These three referral hospitals in the cities of Garoua and Maroua have functional diabetes services, including therapeutic education, nutrition, outpatient consultation, and inpatient units.

All patients with Type 2 Diabetes (T2D) who agreed to consent were included. Patients with other types of diabetes, alternative causes of nephropathy or albuminuria, or those who refused to participate were excluded.

2.2. Sampling

For this hospital-based study, a consecutive, non-probabilistic, exhaustive sampling method was used. The sample size was calculated using OpenEpi version 3 (2013 revision). Considering the number of T2D patients attending outpatient diabetes clinics over one year, 1400 at GRH, 1200 at GGH, and 1700 at MRH, for a total of 4300 patients and assuming a hospital prevalence of DN of 34.6% [10] with a 95% confidence interval, the minimum required sample size was estimated to be 322 patients.

2.3. Data Collection

Ethical clearance (N˚0099/CERSH/NO/2025 and N˚24/CE/25/CRERSH-EN/SG) and administrative authorizations were obtained prior to the start of the study. Participant recruitment began at the Regional Hospital of Garoua due to its higher patient attendance. Outpatients were approached by the principal investigator, and after obtaining oral consent, a pre-established electronic questionnaire, developed using Epi Data Entry 4.0.6.0, was administered through face-to-face interviews, allowing for direct data entry during the survey.

The following data was collected:

- **Sociodemographic data:** sex, region of origin, marital status, place of residence, educational level, occupation, religion, and ethnicity.
- **Diabetes-related data:** type of diabetes, date of diagnosis, mode of diagnosis, family history of diabetes, glycemic control (A1c), frequency of follow-up visits, type of treatment, and diabetes complications (retinopathy and neuropathy known before the study).
- **Other cardiovascular risk factors:** hypertension, smoking, alcohol consumption, physical inactivity, dyslipidemia, and gout.

- **General clinical examination:** weight, height, waist circumference, and blood pressure were measured using standardized procedures.
- **Paraclinical data:** A1c, capillary blood glucose, serum creatinine, microalbuminuria, macroalbuminuria, Albumin-to-Creatinine Ratio (ACR), lipid profile, and fundus examination.

Diabetic Nephropathy (DN) was diagnosed based on the presence of albuminuria (micro and/or macroalbuminuria), measured once either in a spot urine sample or in a 24-hour urine collection, and/or an estimated Glomerular Filtration Rate (eGFR) ≤ 60 mL/min in the presence of microvascular complications, calculated using the MDRD formula.

2.4. Statistical Analysis

Data collected using Epi Data 4.0.6.0 were exported to IBM SPSS version 23 for statistical analysis. Frequencies and percentages were calculated for categorical variables. Continuous variables were described using the mean ± Standard Deviation (SD) or the median [Interquartile Range, IQR], depending on whether the data were normally distributed. Comparisons of continuous variables were performed using Student's t-test or its non-parametric equivalent, and proportions were compared using the chi-square test.

The prevalence of DN was calculated as the proportion of cases among the total number of patients, with 95% Confidence Intervals (CI). Logistic regression analysis was performed to identify determinants of DN. Variables with $p < 0.05$ in univariate analysis were entered into a multivariable logistic regression model to identify determinants. Statistical significance in multivariable analysis was set at $p < 0.05$. Adjusted Odds Ratios (aOR) with 95% confidence intervals were reported.

3. Results

Of the 365 patients seen in the outpatient diabetes clinic, 38 met the exclusion criteria. A total of 327 patients were included in the study. (Figure 1)

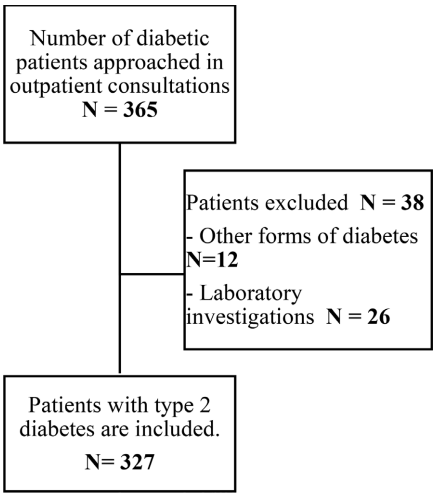

Figure 1. Flowchart of the study population.

3.1. Sociodemographic Characteristics of the Study Population

The study population consisted of 181 (55.4%) men and 146 (44.6%) women, with a male-to-female ratio of 1.24. The median age (IQR) was 54 (46 - 62) years, ranging from 39 to 82 years. The most represented age group was 41 - 50 years (31.5%) (Table 1).

Table 1. Sociodemographic characteristics of the study population.

Variable	Total	Diabetic nephropathy		OR	95% CI	p
		Present N = 80(%)	Absent N = 247(%)			
Sex						
Male	181	46 (25.4)	135 (74.6)	1.12	[0.67 - 1.87]	0.657
Female	146	34 (23.2)	112 (76.8)	1	/	
Age						
≥60 years	105	63 (60.0)	42 (40.0)	18.08	[9.63 - 33.97]	<0.001
<60 years	222	17 (7.6)	205 (92.4)	1	/	

3.2. Clinical Characteristics of the Study Population

The median duration of diabetes (IQR) was 4.6 (2.7 - 10.0) years. More than half (50.2%) had a diabetes duration of less than 5 years, while 27.2% had diabetes for more than 10 years.

The median HbA1c level (IQR) was 10.5% (9.0% - 12.5%). Only 10.7% of patients had well-controlled diabetes (HbA1c ≤ 7%), whereas 89.3% had poorly controlled diabetes (HbA1c > 7%).

Overall, 51.7% of patients reported non-adherence to dietary recommendations, while 48.3% were adherent. Physical inactivity was reported in 66.1% of participants. Most patients (66.3%) were receiving oral antidiabetic therapy consisting of a combination of biguanides and sulfonylureas.

Diabetic neuropathy was present in 67% of patients, and diabetic retinopathy in 19.3% (Table 2).

Table 2. Clinical characteristics of the study population.

Variable	Total	Diabetic nephropathy		OR	95% CI	p
		Present N = 80 (%)	Absent N = 247 (%)			
Duration of diabetes						
≥10 years	89	58 (65.5)	31 (34.5)	18.37	[9.90 - 34.09]	<0.001
<10 years	238	22 (9.2)	216 (90.8)	/	/	
Glycated haemoglobin						
>7%	292	76 (26.0)	216 (74.0)	2.72	[1.28 - 5.09]	0.058

Continued

≤7%	35	4 (11.4)	31 (88.6)	/	/	
Dietary habits						
Non-adherent	169	44 (26.0)	125 (74.0)	1.19	[0.72 - 1.98]	0.494
Adherent	158	36 (22.8)	122 (77.2)	/	/	
Physical activities						
Sedentary	216	58 (26.8)	158 (73.2)	1.48	[0.85 - 2.59]	0.161
Regular	111	22 (19.8)	89 (80.2)	/	/	
Diabetic neuropathy						
Yes	219	79 (36.1)	140 (73.9)	60.37	[8.26 - 440.96]	<0.001
No	108	1 (0.9)	107 (99.1)	/	/	
Diabetic retinopathy						
Yes	63	51 (80.9)	12 (19.0)	34.44	[16.46 - 72.02]	<0.001
No	264	29 (11.0)	235 (89.0)	/	/	

3.3. Cardiovascular Risk Factors

The most common cardiovascular risk factor was physical inactivity (66.1%), followed by abdominal obesity (65.1%) and dyslipidemia (Table 3).

Table 3. Cardiovascular risk factors in the study population

Variable	Total	Diabetic nephropathy		OR	95% CI	p
		Present N = 80 (%)	Absent N = 247 (%)			
Arterial hypertension						
Yes	146	66 (45.2)	80 (54.8)	9.84	[5.21 - 18.57]]	<0.001
No	181	14 (7.7)	167 (92.3)	1	/	
Dyslipidemia						
Yes	172	62 (36.0)	110 (64.0)	4.29	[2.40 - 7.67]	<0.001
No	155	18 (11.6)	137 (88.4)	1	/	
Overweight						
Yes	119	27 (22.7)	92 (77.3)	0.85	[0.51 - 1.46]	0.572
No	208	53 (25.5)	155 (74.5)	/	/	
General obesity						
Yes	19	5 (26.3)	14 (73.7)	1.11	[0.39 - 3.18]	0.847
No	308	75 (24.3)	233 (75.7)			
Abdominal obesity						
Yes	213	55 (25.8)	158 (74.2)	1.24	[0.72 - 2.12]	0.435

Continued

No	114	25 (21.9)	89 (78.1)			
Physical inactivity						
Yes	216	58 (26.8)	158 (73.2)	1.48	[0.85 - 2.59]	0.161
No	111	22 (19.8)	89 (80.2)			
Alcohol consumption						
Yes	49	13 (26.5)	36 (73.5)	1.14	[0.57 - 2.27]	0.715
No	278	67 (24.1)	211 (75.9)			
Smoking						
Yes	20	5 (25.0)	15 (75.0)	1.03	[0.36 - 2.93]	0.954
No	307	75 (24.4)	232 (75.6)			

3.4. Anthropometric Parameters

The median height (IQR) was 1.69 m [1.66 - 1.72], ranging from 1.42 to 1.89 m. Median waist circumference (IQR) was 92 cm [87 - 99]. The median BMI was 23.96 kg/m^2, with overweight (BMI ≥ 25 kg/m^2) present in 36.4% of patients. Abnormal waist circumference according to NCEP-ATP III was observed in 65.1% (Table 4).

Table 4. Anthropometric parameters of the study population.

Variable	Median	IQR	Minimum	Maximum
Weight (kg)	81	[73 - 90]	48	142
Height (m)	1.69	[1.66 - 1.72]	1.42	1.89
Waist circumference (cm)	92	[87 - 99]	70	134
BMI (kg/m^2)	23.96	[21.95 - 26.40]	16.11	40.57

3.5. Clinical Signs of Diabetic Nephropathy

In our study population, 7.9% presented with oliguria/anuria, and 9.1% had facial and/or lower limb edema (Table 5).

Table 5. Clinical signs of diabetic nephropathy.

Signs and symptoms	N = 327	Frequency (%)
Oliguria/anuria	26	7.9
Lower limb edema and/or face	31	9.1

3.6. Prevalence and Factors Associated with Diabetic Nephropathy

The prevalence of DN was 24.5% (95% CI: 19.9% - 29.5%) [microalbuminuria 17.8%; macroalbuminuria 5.5% and eGFR ≤ 60 mL/min with microvascular com-

plications 1.2%]. Multicollinearity among age, diabetes duration, and hypertension was assessed using VIF (1.309, 1.354, 1.402), indicating no significant overlap, thus allowing inclusion in the multivariable model.

Multivariable Analysis: Independent factors associated with DN were age ≥ 60 years [10.33 (4.27 - 25.00), p = 0.004], diabetes duration ≥ 10 years [2.45 (1.02 - 6.03), p = 0.041], diabetic retinopathy [9.52 (3.14 - 28.83), p < 0.001], and diabetic neuropathy [41.35 (4.32 - 95.13), p < 0.001] (Table 6).

Table 6. Independent factors associated with diabetic nephropathy.

Variable	Ajusted OR	95% CI	Ajusted p
Age ≥ 60 years	10.33	[4.27 - 25.00]	0.004
Diabetes duration ≥ 10 years	2.45	[1.02 - 6.03]	0.041
HTN	1.63	[0.62 - 4.32]	0.319
Dyslipidemia	2.06	[0.81 - 5.26]	0.128
Herbal therapy	1.06	[0.42 - 2.65]	0.900
Diabetic retinopathy	9.52	[3.14 - 28.83]	<0.001
Diabetic neuropathy	41.34	[4.32 - 95.13]	<0.001

Stratified analysis by hypertension and dyslipidemia suggested that among patients with hypertension, dyslipidemia had no significant effect on nephropathy. Among patients without hypertension, the absence of dyslipidemia appeared protective. However, the logistic regression model including an interaction term between hypertension and dyslipidemia was not significant (p = 0.295). Thus, although stratification suggested a potential protective effect of the absence of dyslipidemia in patients without hypertension, this was not confirmed in the multivariable model.

4. Discussion

Our study aimed to identify factors associated with Diabetic Nephropathy (DN) among patients with type 2 diabetes in the cities of Garoua and Maroua, including 327 participants. The main findings were:

1) The overall prevalence of DN was high at 24.5% (95% CI: 19.9% - 29.5%), comprising macroalbuminuria (5.5%), microalbuminuria (17.8%), and eGFR ≤ 60 mL/min with diabetic retinopathy and/or neuropathy (1.2%).

2) The main independent risk factors identified [OR (95% CI), p-value] were:

- Age ≥ 60 years: 10.33 (4.27 - 25.00), p = 0.004.
- Duration of diabetes ≥ 10 years: 2.45 (1.02 - 6.03), p = 0.041.
- Diabetic neuropathy: 41.35 (4.32 - 95.13), p < 0.001.
- Diabetic retinopathy: 9.52 (3.14 - 28.83), p < 0.001.

4.1. Prevalence of Diabetic Nephropathy

The overall prevalence of DN in our study was 24.5% (95% CI: 19.9% - 29.5%),

consistent with literature reports ranging from 16.9% to 28% [15]. Bale S. *et al.* in Saudi Arabia (2019) reported 18.9% among 296 patients, Ranjit U. *et al.* in India (2007) reported 2.2%, and Abdulqawi A. *et al.* in Yemen (2019) found 74.5% among 200 patients [16]-[18].

Our results were similar to Ibrahim H. *et al.* in Tchad (2016), who reported 29.83% among 181 patients; Bouenizabila *et al.* in Congo-Brazzaville (2015) found 20.5% among 3700 patients, and *Fayza A.* in Sudan (2012) reported 8.66% [13] [15] [19].

Studies conducted in Cameroon reported prevalences of 34.6% (Ebob M. *et al.*, 2017), 24.5% (Hadja Inna *et al.*, 2024), and 14.2% (Efundem T. *et al.*, 2017) [3] [8] [10].

This variation in prevalence may be attributed to:

- Differences in sample size across studies.
- Variations in DN definitions: some studies considered only macro- or micro-albuminuria, decreased GFR, or albumin-to-creatinine ratio, while others included all parameters.
- Study design differences: retrospective or prospective cross-sectional, cohort, or case-control studies.
- Selection biases due to non-uniform inclusion/exclusion criteria.
- Relatively short study durations.

4.2. Factors Associated with Diabetic Nephropathy

Logistic regression analysis identified advanced age (≥60 years) as significantly associated with DN, consistent with findings from Fayza A. *et al.*, Evelyne K. *et al.*, and Ashutosh K. *et al.* [2] [19] [20]. This association may be explained by the physiological decline of renal function with age, as aging is accompanied by a progressive decrease in Glomerular Filtration Rate (GFR) [21].

A diabetes duration of more than 10 years was also associated with DN, similar to results reported by Ibrahim H. *et al.,* Shehnaz A. *et al.*, and *Abdurahman et al.* [13] [22] [23]. Chronic hyperglycemia, characteristic of diabetes, can induce renal damage through advanced glycation end-products and oxidative injury [21].

Diabetic retinopathy was another major factor associated with DN, in line with Ibrahim H., Abdurahman *et al.,* Asghar S. and Ranjit U. [13] [17] [23] [24]. Diabetic neuropathy was also significantly associated with DN, as reported by Nurul F. *et al.*, Asghar S. *et al.* and Abdulqawi A. *et al.* [18] [22] [24]. These associations can be explained by chronic hyperglycemia-induced tissue vulnerability to oxidative stress, inflammation, and endothelial dysfunction, leading to structural and functional microvascular abnormalities. Target tissues, including the retina, kidneys, and peripheral nerves, are particularly sensitive to intracellular hyperglycemic toxicity due to glucose transporter distribution [25].

Although hypertension, dyslipidemia, and herbal medicine use were associated with DN in bivariate analysis, they were not retained as independent factors in multivariable regression. Nevertheless, the literature reports these factors as con-

tributors to DN: hypertension and dyslipidemia are part of the vascular continuum, while herbal remedies may exert direct nephrotoxic effects [12] [17] [18].

4.3. Study Limitations

This study has several limitations that should be considered when interpreting the results. First, the inclusion of some patients was restricted due to the unavailability of paraclinical examinations, often related to financial constraints. Notably, 26 patients were excluded because they were unable to complete the required laboratory tests, which may have introduced a selection bias by underrepresenting individuals of lower socioeconomic status. They are often at higher risk of poor glycemic control and renal complications and may therefore have led to an underestimation of the true prevalence of diabetic nephropathy in the study population. Second, the relatively short follow-up period may have limited the detection of certain clinical events or the progression of diabetic nephropathy. In addition, alcohol and tobacco consumption, recognized risk factors for diabetic nephropathy may have been underreported due to social desirability bias, potentially affecting the accuracy of these variables.

5. Conclusion

Nearly one-quarter of patients in our study had DN. Independent factors identified were age ≥ 60 years, diabetes duration ≥ 10 years, and the presence of diabetic neuropathy and retinopathy. The high frequency of this silent and dangerous complication underscores the need for early screening, regular monitoring, and preventive strategies in our context.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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