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Diabetic Polyneuropathy and Associated Factors in a Population of Type 2 Diabetic Patients in Garoua, Cameroon

Astasselbe Abba Hadja Inna[1,2*], Arthur Moses Lombat Ngwet[2], Paulette Djeugoue[2], Balkissou Adamou Dodo[2,3], Josiane Mare Njoya[3], Ali Abas[2,3], Almamy Aboubakar Djalloh[2], Aminou Sambo[2,3], Mohamadou Abdou Galdima[2,3], Fadimatou Altine[4], Amadou Ibrahima[1,5], Eugène Sobngwi[6]

[1]Garoua General Hospital, Garoua, Cameroun
[2]Department of Medicine and Traditional Pharmacopeia, Faculty of Medicine and Biomedical Sciences, University of Garoua, Garoua, Cameroun
[3]Garoua Regional Hospital, Garoua, Cameroun
[4]Department of Public Health, Faculty of Medicine and Biomedical Sciences, University of Garoua, Garoua, Cameroun
[5]Department of Physiological Sciences and Biochemistry, Faculty of Medicine and Biomedical Sciences, University of Garoua, Garoua, Cameroun
[6]Department of Internal Medicine and Specialties, Faculty of Medicine and Biomedical Sciences, University of Yaounde I, Yaounde, Cameroun
Email: *hadjainna@yahoo.fr

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Abstract

Introduction: Diabetic polyneuropathy (DPN) is the most common complication of diabetes, affecting nearly half of patients with type 2 diabetes. The aim of this study was to determine the prevalence and factors associated to DPN. **Methods:** We conducted a cross-sectional study from January to May 2024 at the Garoua Regional Hospital (GRH) and the Garoua General Hospital (HGG), involving type 2 diabetic patients. The DN-4 questionnaire, a screening tool for diabetic polyneuropathy comprising 10 items, was used as a diagnostic tool. The diagnosis was established based on a score ≥ 4. A logistic regression model was used to identify factors associated to DPN. The significance level was set at 5%. **Results:** Among the 203 patients included in the study, with a median (IQR) age of 56 (48 - 63) years, 68.5% were female. The median (IQR) duration of diabetes was 5 (2 - 9) years, with a median (IQR) glycated hemoglobin level of 8.80% (7.50% - 10.6%). Dyslipidemia was the most common additional cardiovascular risk factor (65.35%). The prevalence (95% CI) of painful diabetic neuropathy was 45.81% (38.82% - 52.96%). The main associated factors [aOR (95% CI), p] were female sex [3.65 (1.62 - 8.23), p = 0.037], age ≥ 60 years [4.57, (2.11 - 9.86), (p = 0.048)], diabetes duration ≥

10 years [2.93. (1.16 - 7.45), (p = 0.006)], glycated hemoglobin level ≥ 7% [3.99, (1.25 - 5.72), (p = 0.043)] and chronic kidney disease [4.79, (2.22 - 7.54), (p = 0.009)]. **Conclusion:** The high prevalence of diabetic polyneuropathy and its multiple associated factors highlight a major challenge in its prevention, particularly through optimal glycaemic control, in order to improve patients' quality of life.

Keywords

Type 2 Diabetes, Diabetic Polyneuropathy, Associated Factors, Cameroon

1. Introduction

Diabetes is a chronic disease characterized by impaired carbohydrate metabolism. It is a leading cause of mortality and reduces life expectancy [1]. Over the past decade, the prevalence of diabetes mellitus has increased significantly, mainly due to the continuing rise in the incidence of type 2 diabetes [2]. According to the International Diabetes Federation, approximately 537 million people worldwide will be living with diabetes in 2021 [1]. Due to socio-cultural transitions mainly the growing urbanisation and the sedentarisation of the population, Africa has not been spared from this increase. In 2021, 24 million people in Africa will have diabetes, with a prevalence of 4.5% [2]. In Cameroon, the number of diabetics in 2023 is estimated at 2.5 million [3]. In parallel with this rise in the incidence of diabetes, there is an increase in chronic complications affecting patients' quality of life.

Diabetic polyneuropathy (DPN) is one of the most prevalent chronic complications, affecting approximately 50% of type 2 diabetic patients [4]. A multitude of studies have investigated the prevalence of DPN, with estimates ranging from approximately 50% in France, 26% in the UK, 43% in Belgium, and 34% in Saudi Arabia [4]-[7]. Similar figures have been documented on the African continent: 56.7% in Tunisia and 49% in Morocco [8] [9]. In Cameroon, Simo *et al.* found a prevalence of 31.4% in 2020 [10] and Dehayem *et al.* in 2010 found 44.1% in the cities of Douala and Yaoundé respectively [11]. The main risk factors incriminated by the Cameroonian studies were age, female gender, long-standing diabetes, albuminuria, HIV infection, glycemic imbalance, urban residence and hepatitis C virus infection [10]-[12]. However, data from northern Cameroon are scarce. We therefore considered it necessary to assess the prevalence of DPN and the factors associated in Garoua.

2. Methodology

2.1. Study Design and Population

This multicenter cross-sectional study was conducted over a five-month period from January 1 to May 31, 2024, in the diabetology units of Garoua Regional Hospital and Garoua General Hospital. This two referral hospitals in Garoua have

functional diabetology services, including therapeutic education units, nutrition services, outpatient consultation units, and inpatient wards. However, due to its status as a first-category facility within Cameroonian healthcare pyramid, Garoua General Hospital receives more socioeconomically diverse patients compared to Garoua Regional Hospital. All type 2 diabetic patients aged 35 or over who had given informed consent to participate in the study were included. Patients with a non-diabetic cause of peripheral polyneuropathy (alcoholism, chemotherapy, anticonvulsants, psychotropic, antiretrovirals drugs, anti-tuberculosis drugs…) were excluded.

2.2. Sampling

For this in-hospital study, we used consecutive, non-probability, exhaustive sampling.

2.3. Data Collection

We obtained ethical clearance (N˚004/CERSH/NO/2024) and administrative authorizations (N˚2562/23/L/HRG/CM and N˚23-0005/AR/MSP/HGG/DG) prior to the start of the survey. Recruitment of participants began at the Garoua Regional Hospital, as this was the busiest in terms of patient attendance. Outpatients were approached by the principal investigator. After obtaining informed consent, a pre-established electronic questionnaire, prepared using Epi Data Entry 4.0.6.0 software, was administered to patients during a face-to-face exchange, enabling direct data capture during the survey. The following data were collected:

- **Sociodemographic data**: gender, region of origin, marital status, residence (urban, semi-urban or rural), level of education, occupation, income, religion and ethnicity.
- **Diabetes data**: type of diabetes, date and mode of diagnosis, family history of diabetes, diabetes control (glycated hemoglobin level), follow-up visits frequency, type of treatment, complications of diabetes (diabetic retinopathy, chronic kidney disease).
- **Other cardiovascular risk factors**: hypertension, smoking, alcoholism, sedentary lifestyle, dyslipidemia, chronic kidney disease, hyperuricemia/gout.
- **Clinical exam:** weight, height, abdominal circumference, and blood pressure measured using standardized procedures.
- **Neurological foot examination**: assessment began with checking for subjective neurological symptoms and their duration, followed by evaluation of superficial sensation (pain [pin-prick], light touch [cotton wool], temperature [hot/cold]). All exams were performed by the same examiner.
- **Paraclinical data**: glycated hemoglobin (A1c), capillary blood glucose, serum creatinine, lipid profile, and funduscopy.

2.4. Assessment of Diabetic Polyneuropathy

We assessed DPN using the DN-4 questionnaire, a validated screening tool for

diabetic polyneuropathy. It consists of 10 items across four domains (pain characteristics, associated symptoms, pain location, and triggers): 7 interview-based and 3 physical exam-based items: 7 questioning items and 3 physical examination items scored by 0 or 1 according to the absence or presence of symptoms. A total score ≥ 4 indicated DPN, with a sensitivity of 80% and a specificity of 92% (**Table 1**) [13].

Table 1. DN-4 questionnaire.

		Yes = 1	No = 0
QUESTION 1	Does the pain have one or more of the following characteristics:		
	Burning		
	Painful cold sensation		
	Electrical discharges		
QUESTION 2	Is the pain associated in the same area with one or more of the following symptoms:		
	Tingling		
	Tickling		
	Numbness		
	Itching		
QUESTION 3	Is the pain located in a territory where the examination reveals:		
	Hypoesthesia to touch		
	Hypoesthesia to prick		
QUESTION 4	Is the pain provoked or increased by:		
	Friction		

2.5. Statistical Analysis

Data collected on Epi Data 4.0.6.0 were exported to IBM SPSS version 23 for statistical analysis. Frequencies and percentages were calculated for qualitative variables. Mean [standard deviation (SD)] and median [interquartile range (IQR)] were used for quantitative variables based on data distribution. For comparison of continuous variables, we used Student's t test or its non-parametric equivalent. Proportions were compared using the Chi2 test. The prevalence [95% confidence interval (95% CI)] of diabetic peripheral polyneuropathy was calculated as the proportion of cases of diabetic sensitive polyneuropathy over the total number of diabetic patients tested. We used Logistic regression to investigate factors associated with DPN (age, gender, duration of diabetes, diabetes control, comorbidities, chronic complications). Univariate analysis variables with $p < 0.05$ were entered into a single multinomial logistic regression model to determine independent factors associated to DPN. The threshold of significance in this multivariate analysis was set at 0.05. The strength of the association was estimated using the adjusted odds ratio (ORa) and its 95% CI.

3. Results

Out of 247 patients seen in the diabetology clinics, 44 were excluded due to exclu-

sion criteria, resulting in 203 patients definitively included in the study (Figure 1).

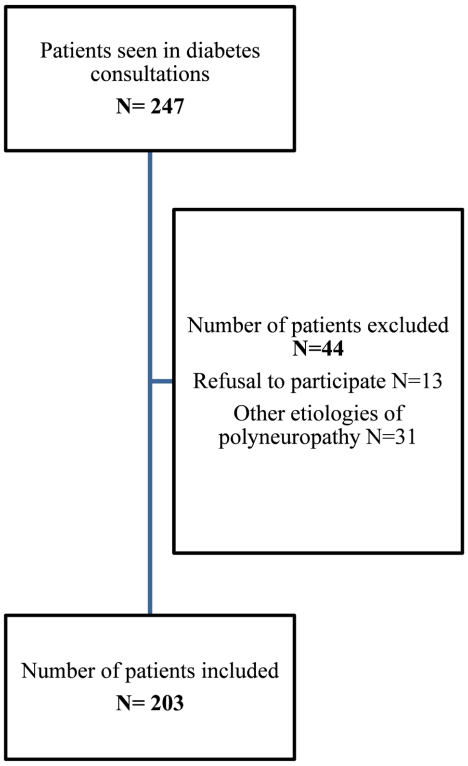

Figure 1. Study population flow diagram.

3.1. Socio-Demographic Data

The study included 64 (31.5%) men and 139 (68.5%) women, with a male-to-female sex ratio of 0.46. The median age (IQR) of patients was 56 (48 - 63) years ranging from 35 to 80 years. The most represented age group was 51 - 60 years (35.50%). A large proportion of patients had no formal education 81 (39.90%) while only 17 (8.37%) patients had university-level education. Nearly half of the participants (45.3%) had a monthly income below 50,000 FCFA (Table 2).

Table 2. Sociodemographic characteristics of the study population.

Variable	Total N = 203	DPN		ORa	95% CI	*p value*
		Present N = 93 (%)	Absent N = 110 (%)			
Sex						
Female	139	73 (52.5)	66 (47.5)	2.43	[1.30 - 4.54]	***0.005***
Male	64	20 (31.2)	44 (68.8)			
Age						
≥60 years	84	57 (40.4)	27 (59.6)	4.87	[2.66 - 8.88]	***<0.001***
<60 years	119	36 (30.3)	83 (69.7)			

Continued

Level of education						
No schooling	81	40 (49.4)	41 (50.6)	1.27	[0.72 - 2.23]	*0.692*
Educated	122	53 (43.4)	69 (56.6)			
Salary income						
<50,000 Fcfa	92	44 (47.8)	48 (52.2)	1.16	[0.66 - 2.02]	*0.275*
≥50,000 Fcfa	111	49 (44.1)	62 (55.9)			

3.2. Clinical Data

The median diabetes duration (IQR) was 5 (2 - 9) years. Almost half (47.29%) of the patients had had diabetes for less than 5 years, while 21.18% had diabetes for 10 years or more.

In our study population, 170 (83.74%) patients had performed a glycated hemoglobin within the last 3 months. The median (IQR) A1c was 8.80% (7.50% - 10.6%). Among these, only 14.71% had controlled diabetes (A1c < 7%), while 22.94% had moderately uncontrolled diabetes (A1c 7% - 8%), and 62.35% had poorly controlled diabetes (A1c ≥ 8%).

Table 3. Clinical characteristics of the study population.

Variable	Total	DPN		ORa	95% CI	*p value*
		Present N = 93 (%)	Absent N = 110 (%)			
Age of diabetes						
≥10 years	43	31 (72.1)	12 (27.9)	4.08	[1.95 - 8.54]	***<0.001***
<10 years	160	62 (38.8)	98 (61.2)			
A1c						
≥7%	145	79 (54.5)	66 (45.5)			
<7%	25	6 (24.0)	19 (76.0)	3.79	[1.43 - 10.04]	***0.005***
Dietary and hygienic measures						
Not complied	70	35 (50.0)	35 (50.0)	1.29	[0.72 - 2.31]	*0.385*
Adhered to	133	58 (43.6)	75 (56.4)			
Treatment						
Insulin therapy	25	10 (40.0)	15 (60.0)	0.73	[0.35 - 1.79]	*0.388*
Others	178	83 (46.6)	95 (53.4)			
Diabetic retinopathy						
Yes	13	12 (92.3)	1 (7.7)	14.16	[1.77 - 112.72]	***0.002***
No	109	50 (45.8)	59 (54.2)			
Chronic kidney disease						
Yes	26	24 (92.3)	2 (7.7)	16.90	[3.79 - 75.27]	***<0.001***
No	106	44 (41.5)	62 (58.5)			

Most patients (65.22%) reported adhering to dietary recommendations and 50.74% practiced regular physical activity. Oral antidiabetic drugs were used by 72.41% of the patients.

Fundus examination was performed in 60.10% of the sample. Among them, 13 patients (10.66%) had diabetic retinopathy. Of the 158 patients with serum creatinine measured, 19.7% had an estimated creatinine clearance < 60 ml/min (Cockcroft formula) (Table 3).

3.3. Cardiovascular Risk Factors

With regard to cardiovascular risk factors, 43.8% of patients had arterial hypertension. A total of 11.3% of patients reported regular alcohol consumption. Only 2.9% of patients were tobacco smokers, while 1.4% had quit smoking at least 3 years previously (Table 4).

Table 4. Cardiovascular risk factors.

Variable	Total	DPN		ORa	95% CI	*p value*
		Present N = 93 (%)	Absent N = 110 (%)			
Arterial hypertension						
Yes	89	50 (56.2)	39 (43.8)	2.11	[1.20 - 3.72]	***0.009***
No	114	43 (37.7)	71 (62.3)			
Alcoholism						
Yes	23	12 (40.0)	11 (60.0)	1.33	[0.56 - 3.18]	*0.516*
No	180	81 (45.0)	99 (50.0)			
Smoking						
Yes	6	4 (66.7)	2 (33.3)	2.42	[0.43 - 13.56]	*0.298*
No	197	89 (45.2)	108 (54.8)			
Overweight						
Yes	115	64 (55.7)	51 (44.3)	2.55	[1.43 - 4.54]	***0.001***
No	88	29 (32.9)	59 (67.1)			
Sedentary lifestyle						
Yes	100	58 (58.0)	42 (42.0)	2.68	[1.51 - 4.74]	***0.001***
No	103	35 (33.9)	68 (66.1)			
Abdominal obesity						
Yes	97	57 (58.7)	40 (41.3)	2.77	[1.57 - 4.90]	<***0.001***
No	106	36 (34.0)	70 (66.0)			
Total cholesterol (g/L)						
≥2	35	19 (54.2)	16 (45.8)	1.12	[0.52 - 2.77]	*0.682*
<2	66	33 (50.0)	33 (50.0)			
Triglycerides (g/L)						
≥1.5	63	37 (58.7)	26 (41.3)	2.18	[0.96 - 4.96]	*0.061*
<1.5	38	15 (39.4)	23 (60.6)			

Continued

LDL (g/L)						
≥1.6	10	5 (50.0)	5 (50.0)	0.94	[0.25 - 3.45]	*0.921*
<1.6	91	47 (51.6)	44 (48.4)			
HDL (g/L)						
<0.4 (if Male) <0.5 (if Female)	66	40 (60.6)	26 (39.4)	2.94	[1.25 - 6.93]	***0.012***
≥0.4 (if Male) ≥0.5 (if Female)	35	12 (34.2)	23 (65.8)			

3.4. Anthropometric Parameters

Table 5 summarizes the anthropometric parameters of our study population. The median waist circumference (IIQ) in our sample was 91 cm (82 - 102 cm). Women had a median waist circumference (IIQ) of 89 cm (78 - 98 cm) and men 99 (92 - 107 cm).

Participants' median BMI (IIQ) was 26.51 (22.75 - 30.83) kg/m^2 and 56.65% patients had a BMI ≥ 25 kg/m^2.

Using the American NCEP-ATP III classification for the gender distribution of our sample, we note that 47.7% of patients were android obese (Table 5).

Table 5. Anthropometric parameters

Variable	Median	IQI	Minimum	Maximum
Weight (kg)	72	[63 - 86]	45	131
Height (m)	1.65	[1.60 - 1.70]	1.50	1.89
Waist circumference (cm)	91	[82 - 102]	61	120
BMI (kg/m^2)	26.51	[22.75 - 30.83]	16.30	45.87

BMI: Body mass index.

3.5. Clinical Signs of DPN

Burning was the main symptom, with a frequency of 90.3% in the DPN population. Followed by tingling sensation, present in 80.6% of patients (Table 6).

Table 6. Clinical signs of DPN.

	Number (N = 93)	Frequency (%)
Symptoms		
Burning	84	90.32
Painful cold	23	24.73
Electric discharge	41	44.10
Tingling	75	80.64
Tickling	58	62.37
Numbness	61	65.59
Itching	32	34.41

Continued

Objective sensory disorders		
Hypoesthesia to touch	75	80.66
Hypoesthesia to sting	27	29.01

3.6. Prevalence and Associated Factors to DPN

The prevalence (95% CI) of DPN in our study population was 45.81% (38.82 - 52.96)%.

Multivariate analysis was carried out on a sample of 101 patients, due to the fact that some of our patients did not undergo complementary examinations. The independent factors associated [ORa (95% CI), p] with DPN were female gender [3.65 (1.62 - 8.23), p = 0.037]; age ≥ 60 years [4.57 (2.11 - 9.86), p = 0.048]; duration of diabetes progression [2.93 (1.16 - 7.45), p = 0.006]; hyperglycemic imbalance with HbA1c ≥ 7% [3.99 (1.25 - 5.72), p = 0.043] and chronic renal failure [4.79 (2.22 - 7.54), p = 0.009] (Table 7).

Table 7. Associated factors to DPN.

Variables	Ajusted OR	95% CI	*Ajusted p*
Female gender	3.65	[1.62 - 8.23]	***0.037***
Age ≥ 60 years	4.57	[2.11 - 9.86]	***0.048***
Dyslipidemia	2.40	[0.71 - 8.07]	*0.071*
Diabetes duration ≥ 10 years	2.93	[1.16 - 7.45]	***0.006***
A1c ≥ 7%	3.99	[1.25 - 5.72]	***0.043***
Diabetic retinopathy	2.94	[1.10 - 7.25]	*0.065*
Chronic kidney disease	4.79	[2.22 - 7.54]	***0.009***

4. Discussion

The aim of our study was to identify the factors associated with diabetic peripheral polyneuropathy in patients with type 2 diabetes in the city of Garoua. We included 203 patients and the main findings were:

1) The prevalence of DPN was high;

2) The main identified risk factors were female gender, age over 60, duration of diabetes over 10 years, chronic hyperglycemic imbalance and chronic kidney disease.

4.1. Prevalence of Diabetic Polyneuropathy

In our study, the prevalence (95% CI) of DPN was 45.81 (38.82 - 52.96)%. This result is similar to the results reported by Dehayem *et al.* in Cameroon on a sample of 376 patients and Aynaou *et al.* in Morocco on a cohort of 391 patients, which were 44.1% and 40% respectively. Both used the same diagnostic tool, the DN-4 questionnaire [8] [11].

Studies using other diagnostic criteria reported higher prevalence rates. Using the Michigan Neuropathy Screening Instrument (MNSI), Elleuch *et al.* found a prevalence of 57.8% [4]. Conversely, studies that employed electroneuromyography (ENMG) found lower rates. Mojaddidi *et al.* reported a prevalence of 16.4% in Saudi Arabia using ENMG, identifying subclinical DPN [14].

Thus, diagnostic tools significantly influence reported prevalence rates. This was confirmed in a 2022 Saudi Arabian meta-analysis by Owolabi *et al.*, which included 12 studies using different diagnostic methods. Studies relying on questionnaires and clinical exams showed a pooled prevalence of 48% [46% - 50%], while those using nerve conduction studies reported a prevalence of 26% [15% - 36%] [6].

4.2. Factors Associated with Diabetic Polyneuropathy

The study of associated factors with DPN concluded that the female sex is involved. Many authors reported similar results. These include Hode *et al.* ($p = 0.022$) and Halawa *et al.* ($p = 0.001$) [15] [16]. However, some studies reported opposite results. Sani *et al.* found an association between male sex and DPN in their study ($p = 0.017$), explained by the predominantly male prevalence in their population [17].

We noted a significant relationship between advanced age (60 years) and DPN. This has also been reported by Sani *et al.* and Halawa *et al.* [16] [17].

In univariate analysis, both overweight and abdominal obesity were significantly associated with DPN, likely due to sensory dysfunction in small nerve fibers [18]. However, in multivariate analysis, BMI and waist circumference were not independent predictors.

Long-standing diabetes is a well-established major associated factor. Moreover, there was a positive correlation between the duration of diabetes and DPN, with a clearer correlation from 10 years onwards. This was demonstrated by logistic regression. The correlation has been confirmed by several studies, notably those by Bassanguen *et al.* and Halawa *et al.* [16] [19].

The role of hyperglycemia is clearly established in the onset and aggravation of DPN. Vinik *et al.* have demonstrated that poor glycemic control ($A1c \geq 7\%$) increases the risk of developing DPN by more than fivefold. According to our work, hyperglycemic imbalance is linked to the occurrence of DPN, with an $aOR = 3.99$, in case of $A1c \geq 7\%$. Similar results reported by Hode *et al.* [15].

In our study, chronic kidney disease was a significant predictor of the occurrence of DPN. Bassanguen *et al.* and Sani *et al.* highlighted this relationship, which is similar to our data [17] [19].

4.3. Study Limitations

Many patients faced financial barriers to completing certain paraclinical investigations. Thus, almost all the data collected was based on a pre-established questionnaire, completed during the consultation, with all the hazards inherent to this

environment, notably the often stressful hospital atmosphere, which could alter the quality of patients' answers. Screening for DPN using this questionnaire was based on subjective responses, influenced by the patient's psychic disposition at the time of the interview.

The exclusive use of the DN-4 questionnaire to diagnose DPN could be responsible for overestimating the prevalence of DPN. The use of nerve conduction studies, even on a sub-sample of participants, would have improved diagnostic accuracy and strengthened the validity of the results.

5. Conclusion

Diabetic polyneuropathy is a highly prevalent complication of diabetes that significantly impacts patient quality of life. This study showed that almost half of our patients were affected by this complication. The identified independent associated factors in multivariate analysis were female gender, age ≥ 60 years, diabetes duration more than 10 years, poor glycemic control (A1c ≥ 7%) and chronic kidney disease.

Conflicts of Interest

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

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