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Peripheral Neuropathy in Diabetes Patients at Jimma University Medical Center: Magnitude and Contributing Factors

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ABSTRACT

Diabetes mellitus often leads to long-term complications that significantly affect patient health and survival. Among these complications, diabetic peripheral neuropathy (DPN) is the most common and can result in serious consequences if left undetected. Early identification through reliable screening methods is essential, and the Michigan Neuropathy Screening Instrument (MNSI) serves as a practical tool for this purpose in clinical practice. However, information regarding the occurrence and contributing factors of DPN in the Jimma area is limited. This study, therefore, aimed to determine how common DPN is and to explore the factors associated with it among patients with type 1 diabetes mellitus (T1DM) attending Jimma University Medical Center (JUMC) between January 2 and March 31, 2020. A cross-sectional study was conducted at the institution, with diabetic peripheral neuropathy (DPN) evaluated using the Michigan Neuropathy Screening Instrument (MNSI). Information was gathered using a structured questionnaire that had been pretested, entered into EPI Data version 3.1, and subsequently analyzed in SPSS version 20. Variables showing a p-value below 0.25 in the initial bivariable logistic regression were included in the multivariable analysis to account for potential confounding effects. In the final model, adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated, and associations were deemed statistically significant at a p-value of ≤0.05. During the study period, 217 individuals with type 1 diabetes mellitus (T1DM) who fulfilled the inclusion criteria were enrolled consecutively. The average age of the participants was 43 years (±15.5). Diabetic peripheral neuropathy (DPN) was detected in 37.3% of the study population. Factors independently associated with DPN in multivariable logistic regression included advancing age—specifically, 40–49 years (AOR = 3.80; 95% CI: 1.30–10.60) and 50 years or older (AOR = 6.50; 95% CI: 2.50–16.50)—as well as smoking, with current smokers (AOR = 3.40; 95% CI: 1.20–9.50) and former smokers (AOR = 2.70; 95% CI: 1.60–6.80) at higher risk. Additionally, having coexisting hypertension was linked to increased odds of DPN (AOR = 2.40; 95% CI: 1.00–5.40). Diabetic peripheral neuropathy (DPN) was found to be highly prevalent among diabetes patients at JUMC. Prompt screening and proper management are especially crucial for individuals who are older, have hypertension, or smoke.

Keywords: Diabetic peripheral neuropathy, Prevalence, Type 1 diabetes mellitus, Ethiopia

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Introduction

Diabetes mellitus (DM) ranks among the most widespread metabolic disorders globally and represents a significant public health concern. Current estimates suggest that around 9% of adults worldwide are affected [1]. In Africa, approximately 39 million people were living with DM in 2017, with projections indicating an increase to 82 million by 2045. As the burden of diabetes grows, complications related to the disease are also expected to rise [1, 2].

One of the most frequent and debilitating long-term complications of diabetes is diabetic peripheral neuropathy (DPN) [3]. While both type 1 (T1DM) and type 2 diabetes are susceptible to DPN, it tends to manifest more rapidly and severely in T1DM due to the earlier onset of disease [4, 5]. DPN is defined as evidence of peripheral nerve dysfunction in patients with diabetes, after excluding other potential causes [6, 7]. Its prevalence among

T1DM patients varies across different populations. For example, a longitudinal study reported an initial prevalence of 6% in adults with T1DM, rising to 30% after 13–14 years [8]. In Australia, 21% of adolescents with T1DM were found to have DPN [9]. In Ethiopia, prevalence estimates include 33.3% in Addis Ababa [10], 51.2% in Bahirdar [11], and 16.4% in Jimma [12].

DPN significantly impairs quality of life, contributing to foot ulcers, altered gait, neuropathic pain, and frequent hospitalizations. It is responsible for more hospital admissions than any other diabetic complication and accounts for 50–75% of non-traumatic amputations [13, 14]. Evidence shows that targeted interventions can reduce the risk of ulcers by 60% and amputations by 85% among high-risk patients [15].

Since DPN is largely irreversible, prevention is essential. Risk factors associated with its development in T1DM include longer diabetes duration, advancing age, poor blood sugar control, smoking, and higher body mass index (BMI) [16–18]. Early detection is critical because subclinical neuropathy can precede symptoms. The American Diabetes Association recommends screening all adults with diabetes for DPN at diagnosis and annually thereafter [19]. The Michigan Neuropathy Screening Instrument (MNSI) is a simple, validated, and effective tool for this purpose [20].

Despite its clinical importance, screening for DPN remains limited in Ethiopia, and little is known about its burden among T1DM patients, particularly in Jimma. Moreover, most research has focused on type 2 diabetes. This study aimed to evaluate the prevalence and associated factors of DPN in T1DM patients attending follow-up at Jimma University Medical Center (JUMC) using the MNSI. The results will provide insight into the magnitude of the problem locally and offer baseline information to guide early detection and appropriate interventions.

Materials and Methods

Study area, period and design

This study employed a hospital-based cross-sectional design and was conducted at Jimma University Medical Center (JUMC) in Jimma town, located in the Jimma Zone of the Oromia region, Southwest Ethiopia, between January 2 and March 31, 2020. JUMC is one of Ethiopia's largest medical facilities, catering to a broad population in the southwestern part of the country. The hospital offers a wide array of specialized services, including routine follow-up and management for patients with chronic conditions such as diabetes mellitus and hypertension.

Selection of study subjects

During the three-month study period, 217 adults diagnosed with type 1 diabetes mellitus (T1DM) who satisfied the inclusion criteria were enrolled consecutively. Patients under 18 years, those with type 2 diabetes, pregnant women, individuals living with HIV, those with alcohol use disorders, critically ill patients, and those with psychiatric conditions were excluded from participation. In cases where patients attended the clinic multiple times during the study period, information was collected only during their first visit.

Data collection tool and procedure

nformation was gathered using a structured, interviewer-administered questionnaire that had been pretested and developed based on a review of several relevant studies [11, 12, 21, 22]. The questionnaire was initially drafted in English, translated into the local languages, and then back-translated to English by language experts to ensure accuracy and consistency of meaning. Data collection involved face-to-face interviews, physical examinations, and review of patient medical records. The questionnaire was organized into four main sections covering socio-demographic information, behavioral factors, clinical characteristics, and the Michigan Neuropathy Screening Instrument (MNSI).

Physical measurements

Anthropometric and Clinical Measurements: Participants' height was measured with a stadiometer to the nearest 0.1 cm while standing upright on a level surface, and body weight was recorded to the nearest 0.1 kg using a calibrated scale with light clothing. Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters. Additional clinical information was extracted from patient records. Behavioral factors were assessed following the World Health Organization's STEPwise approach for chronic disease risk surveillance [22].

Evaluation of Diabetic Peripheral Neuropathy (DPN): DPN was screened using the Michigan Neuropathy Screening Instrument (MNSI), a validated, noninvasive tool with reported sensitivity and specificity of 80% and 95%, respectively [20]. The MNSI consists of two parts: a symptom-based history questionnaire and a physical examination, both administered by trained personnel.

MNSI History Component: This section contains 15 questions, but only 13 items were scored to assess neuropathic symptoms. Points were assigned based on responses: "Yes" to items 1–3, 5, 6, 8, 9, 11, 12, 14, and 15, and "No" to items 7 and 13 each received one point. Items 4 and 10 were excluded from scoring. Scores range from 0 to 13, with a score of 7 or higher indicating the presence of DPN [21].

MNSI Physical Examination: The foot examination included inspection for deformities, ulceration, assessment of vibration sense at the great toe using a 128-Hz tuning fork, testing of ankle reflexes with a standard hammer, and sensation testing with a 5.07/10-g monofilament at nine plantar sites and one dorsal site per foot. Scoring followed standard MNSI guidelines: foot appearance (0 = normal, 1 = abnormal), ulcers (0 = absent, 1 = present), ankle reflexes (0 = present, 0.5 = present with reinforcement, 1 = absent), vibration perception (0 = normal, 0.5 = reduced, 1 = absent), and monofilament results (0 = 8–10 correct, 0.5 = 1–7 correct, 1 = no correct responses). Each foot was scored independently, and the scores were combined [21].

Data Collection and Quality Assurance: Three medical interns conducted the data collection under the supervision of two senior supervisors and the principal investigator. All data collectors underwent intensive training to reduce variability between and within examiners. Additionally, each physical examination was independently cross-checked by the supervisors to ensure accuracy.

Operational definitions

Diabetic Peripheral Neuropathy (DPN): DPN was considered present if a participant scored 7 or higher on the MNSI history questionnaire or 2.5 or higher on the MNSI physical examination.

Controlled Fasting Blood Glucose: Fasting blood sugar levels between 80 and 130 mg/dL were regarded as within the target range.

Critically Ill Patients: Individuals unable to communicate effectively at the time of data collection.

Type 1 Diabetes Patient: Any patient diagnosed with T1DM who was attending follow-up care at JUMC.

Alcohol Use Disorder: Defined in this study as the consumption of six or more standard drinks in a single occasion for men, or four or more standard drinks for women.

Standard Drink: A beverage containing approximately 10 grams of pure alcohol.

Statistical analysis

Data were reviewed daily by the principal investigator and supervisors to ensure completeness and accuracy, both before and after entry. The verified data were entered into EpiData version 3.1 and then exported to SPSS version 20 for analysis. Descriptive statistics, including means, percentages, and standard deviations, were calculated as appropriate. Bivariable logistic regression was conducted to explore the relationship between the outcome variable and each independent variable. Variables with a p-value <0.25 in the bivariable analysis were included in the multivariable logistic regression model. The multivariable analysis was performed using a backward stepwise approach to identify independent predictors of the outcome. Variables showing a significant association were reported using adjusted odds ratios (AOR) with 95% confidence intervals (CI) and a p-value ≤ 0.05. Model fitness was assessed using the Hosmer-Lemeshow goodness-of-fit test, which yielded a p-value of 0.707, indicating an acceptable fit.

Data quality assurance

To maintain high-quality data collection, the principal investigator provided comprehensive training to both data collectors and supervisors, covering the study objectives, interviewing techniques, chart review procedures, and measurement methods. The questionnaire was first developed in English, translated into the local language, and then back-translated to English to ensure accuracy and consistency. Any discrepancies between the versions were identified and resolved. Before the main study, the questionnaire was pretested on T1DM patients at Shenen Gibe Hospital to verify its clarity and validity. Throughout the data collection period, the supervisors and principal investigator conducted continuous oversight, and completed questionnaires were reviewed daily to ensure they were accurate, complete, and clear.

Ethical approval and consent to participate

Ethical approval for the study was granted by the Institutional Review Board (IRB) of Jimma University. A formal support letter was submitted to the outpatient unit manager at JUMC. Participants were thoroughly informed about the study's objectives and potential benefits, and data were collected only after obtaining oral informed consent from each individual. All information was recorded anonymously, and confidentiality was strictly maintained throughout the study. The research was conducted in full compliance with the principles of the Declaration of Helsinki.

Results and Discussion

Socio-demographic characteristics of participants

A total of 217 individuals participated in the study, yielding a 100% response rate. The mean age of the participants was 43 ± 15.5 years. Males accounted for more than half of the sample (55.8%), and approximately one-quarter (26.7%) reported a family history of diabetes mellitus. In terms of religion, nearly half of the participants (45.6%) were Muslim, and the majority (72.8%) were married **(Table 1)**.

Table 1. Socio-demographic characteristics of participants at JUMC 2020, Ethiopia (n = 217).

Variable	Category	Number	Percentage (%)
Sex	Male	121	55.8
	Female	96	44.2
Residence	Urban	108	49.8
	Rural	109	50.2
Family History of DM	Yes	58	26.7
	No	159	73.3
Age (years)	<30	65	30.0
	30–39	21	9.7
	40–49	48	22.1
	≥50	83	38.2
Marital Status	Married	158	72.8
	Single	33	15.2
	Others*	26	12.0
Ethnicity	Oromo	120	55.3
	Amhara	63	29.0
	Others†	34	15.7
Religion	Muslim	99	45.6
	Orthodox	81	37.3
	Protestant	37	17.1
Educational Status	Illiterate	56	25.8
	Primary	107	49.3
	Secondary & above	54	24.9
Occupational Status	Housewife	51	23.5
	Farmer	58	26.7
	Private worker	54	24.9
	Government employee	48	22.1
	Others‡	6	2.8
Average Monthly Income (ETB)	<1000	59	27.2
	1000–2999	95	43.8
	≥3000	63	29.0

∗Widowed, divorced; † Yem, Keffa, Tigre; ‡ Retired, unemployed; ETB = Ethiopian birr.

Behavioral and clinical characteristics of participants

The average duration of diabetes among participants was 5.1 ± 4.5 years, and the majority (73.7%) fell within the normal BMI range. Concerning behavioral factors, almost half of the participants (47.5%) reported being physically active, while 11.5% were current smokers **(Table 2)**.

Table 2. Clinical and behavioral characteristics of participants at JUMC 2020, Ethiopia (n = 217).

Variable	Category	Number	Percentage (%)
Sex	Male	121	55.8
	Female	96	44.2
Residence	Urban	108	49.8
	Rural	109	50.2
Family History of DM	Yes	58	26.7
	No	159	73.3
Age (years)	<30	65	30.0
	30–39	21	9.7
	40–49	48	22.1
	≥50	83	38.2
Marital Status	Married	158	72.8
	Single	33	15.2
	Others*	26	12.0
Ethnicity	Oromo	120	55.3
	Amhara	63	29.0
	Others†	34	15.7
Religion	Muslim	99	45.6
	Orthodox	81	37.3
	Protestant	37	17.1
Educational Status	Illiterate	56	25.8
	Primary	107	49.3
	Secondary & above	54	24.9
Occupational Status	Housewife	51	23.5
	Farmer	58	26.7
	Private worker	54	24.9
	Government employee	48	22.1
	Others‡	6	2.8
Average Monthly Income (ETB)	<1000	59	27.2
	1000–2999	95	43.8
	≥3000	63	29.0

Prevalence of DPN

Diabetic peripheral neuropathy (DPN) in this study was determined using both the MNSI history and examination scores. When assessed by symptoms alone, 19 participants (8.8%) were identified with DPN, while 72 participants (33.2%) were positive based on physical signs. Considering both the history and examination components together, the overall prevalence of DPN among the study population was 81 participants (37.3%).

Factors independently associated with DPN

Independent predictors of diabetic peripheral neuropathy (DPN) were identified through multivariable logistic regression after including variables that were significant in the bivariable analysis. Out of seven candidate factors, three were significantly associated with DPN: age, hypertension, and smoking status.

Patients aged 40–49 years had nearly four times higher odds of developing DPN compared to those under 30 years [AOR = 3.80; 95% CI: 1.30–10.60; p = 0.011], while participants aged 50 years or older were over six times more likely to have DPN [AOR = 6.50; 95% CI: 2.50–16.50; p ≤ 0.001]. Current smokers had 3.4-fold increased risk compared to never smokers [AOR = 3.40; 95% CI: 1.20–9.50; p = 0.02], and former smokers were 2.7 times more

likely to develop DPN than non-smokers [AOR = 2.70; 95% CI: 1.60–6.80; p = 0.042]. Additionally, participants with coexisting hypertension were more than twice as likely to develop DPN compared to those without hypertension [AOR = 2.40; 95% CI: 1.00–5.40; p = 0.039] **(Table 3)**.

Table 3. Key independent factors linked to diabetic peripheral neuropathy in adult patients at JUMC, 2020 (n = 217).

Variable	Category	DPN Yes	DPN No	Bivariable Analysis	Multivariable Analysis
				P-value	COR (95% CI)
Age (years)	<30	8	57	1	1
	30–39	4	17	0.442	1.67 [0.45–6.30]
	40–49	23	25	≤0.001	6.50 [2.60–16.60]
	≥50	46	37	≤0.001	8.80 [3.80–20.90]
Sex	Male	52	69	0.054	1.70 [0.98–3.06]
	Female	29	67	1	1
Residence	Urban	45	63	0.189	1.40 [0.83–2.50]
	Rural	36	73	1	1
BMI (kg/m²)	18.5–24.9	53	107	1	1
	<18.5	6	15	0.676	0.80 [0.30–2.20]
	≥25	22	14	0.002	3.00 [1.50–6.70]
Smoking	Current	16	9	0.001	4.30 [1.70–10.30]
	Former	18	14	0.004	3.00 [1.40–6.70]
	Never	47	113	1	1
Comorbid Hypertension	Yes	27	15	≤0.001	4.00 [1.98–8.20]
	No	54	121	1	1
Duration of DM (years)	<5	46	77	1	1
	5–10	19	44	0.328	0.70 [0.40–1.40]
	≥10	16	15	0.152	1.70 [0.80–3.90]

value statistically significant; AOR- Adjusted Odds ratio; COR-Crude odds ratio; CI-Confidence interval; 1-reference.

This study investigated the prevalence and determinants of diabetic peripheral neuropathy (DPN) among patients with type 1 diabetes mellitus (T1DM). Using the Michigan Neuropathy Screening Instrument (MNSI) history version, the prevalence of DPN was 8.8%, whereas the MNSI examination identified a higher prevalence of 33.2%. This disparity highlights the superior sensitivity of the MNSI examination in detecting early neuropathic changes and underscores the limitations of relying solely on patient-reported symptoms. Consequently, it is important to screen all diabetic patients for DPN, even if they do not report neuropathic complaints. When combining both the MNSI history and examination tools, the overall prevalence was 37.3% [95% CI: 30.90, 43.80], suggesting that integrating these two approaches is effective for early DPN detection.

These findings are comparable to reports from Addis Ababa, Ethiopia (33.3%), Austria (34.2%), and Porto, Portugal (42.8%) [10, 23, 24]. Conversely, the prevalence in our study was higher than that reported in Spain (12.9%), the United States (7%), and China (21.92%) [25–27], potentially reflecting variations in study design, population characteristics, healthcare resources, and diagnostic criteria. For instance, a study in Jimma, Ethiopia, reported a prevalence of 16.4% [12], which may be explained by their use of medical record reviews rather than direct screening with MNSI.

On the other hand, our prevalence was lower than findings from Denmark (62%) [28], Iran (57.5%) [29], and Egypt (61.7%) [30]. These differences may be attributed to longer diabetes duration in those populations, reliance on single assessment measures, variations in sampling techniques, and differences in diagnostic methodology. Similarly, a study in Bahirdar, Ethiopia, reported a prevalence of 51.2% among T1DM patients [11], which could be influenced by differences in sample size and sampling strategies.

In line with prior studies, our analysis revealed that age above 40 years was associated with a higher risk of DPN [26, 31, 32]. This may reflect age-related physiological decline and increased vulnerability of the nervous system

to long-term metabolic stress. Additionally, smoking was significantly linked to an elevated risk of DPN [24, 26, 33], possibly due to the neurotoxic effects of tobacco, inflammation, endothelial dysfunction, and oxidative stress, which collectively impair neuronal function [34].

Finally, comorbid hypertension (HTN) was associated with a 2.4-fold higher likelihood of developing DPN compared to patients without HTN [24, 26, 28]. Animal studies suggest that hypertension may contribute to neuropathy through damage to the myelin sheath surrounding axons [35].

Conclusion

The prevalence of DPN among T1DM patients at JUMC was substantial. Risk factors identified include age above 40 years, coexisting hypertension, and smoking. These findings underscore the importance of targeted interventions for high-risk groups to prevent further complications and improve patient outcomes.

Limitations

Several limitations should be acknowledged. First, the study was conducted at a single institution, limiting generalizability to all diabetic patients in the country. Second, nerve conduction studies, the gold standard for neuropathy diagnosis, were not performed. Third, recall bias may have affected responses on the MNSI history questionnaire. Fourth, the study could not account for all potential predictors of DPN and may not be applicable to patients with type 2 diabetes. Finally, the cross-sectional design prevents establishing temporal or causal relationships, and less common causes of neuropathy, such as vasculitis or vitamin B deficiencies, were not excluded.

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