ORIGINAL ARTICLE

Diabetic Peripheral Neuropathy in Patients with Type 2 Diabetes: Frequency and Associated Factors in Primary Care

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Abstract

Background: Diabetes is widely recognized as a global public-health challenge, often described as a silent killer due to its insidious onset and devastating complications. Nearly half of all individuals with diabetes develop peripheral neuropathy, which is recognized as a chronic complication of diabetes.

Objective: To determine the frequency and associated factors of diabetic peripheral neuropathy (DPN) in patients with type 2 diabetes visiting primary care clinics in Karachi.

Methodology: This cross-sectional study was conducted at Family Medicine Clinics at Liaquat National Hospital and its community-based outreach centers in Karachi, Pakistan, from December 2024 to June 2025. Screening for Diabetic Peripheral Neuropathy (DPN) was performed using the Michigan Neuropathy Screening Instrument (MNSI) tool. Diabetic peripheral neuropathy was considered positive when patients reported clinical symptoms (a score of at least 7 out of 13) or had physical examination results confirming the presence of neuropathy (a score of greater than 2 out of 10).

Results: A total of 260 subjects were evaluated in this study, with a mean age of 53.5±11.7 years; 59.6% were male. On average, diabetes duration was 7.5±3.8 years. DPN was present in 19.2% of participants based on clinical symptoms and 55% based on the physical examination of the MNSI tool. The overall frequency of diabetic peripheral neuropathy based on either clinical symptoms or physical examination was 56.5%. In a multivariable regression analysis, factors that were found to be significantly associated with diabetic peripheral neuropathy were longer diabetes duration and a high BMI.

Conclusion: Our research found high rates of diabetic peripheral neuropathy in primary care clinics, particularly among those with longer disease duration and patients with elevated BMI, emphasizing continuous surveillance and timely management for strengthening community-level care.

Keywords: *Diabetic peripheral neuropathy, Michigan neuropathy screening instrument, peripheral nervous system, primary care, type 2 diabetes.*

INTRODUCTION

Diabetes has become an important public health concern and a notable contributor to illness and death in the 21st century. It is presently estimated that a large global population suffers from diabetes [1]. According to the International Diabetes Federation report, 463 million people around the globe are diagnosed with diabetes [2]. Moreover, 26.7% of Pakistani adults have diabetes; thus, it ranks third in prevalence after China and India [3]. Due to the increasing shift toward unhealthy dietary patterns and sedentary lifestyles, type-2 diabetes mellitus has become a major public health concern. It is associated with several severe complications including blindness, amputation, heart diseases, renal failure, and early mortality [2].

Diabetic peripheral neuropathy (DPN) is one of the established chronic outcomes of diabetes that affects up to 50% of patients [4, 5]. The occurrence of DPN is in keeping with rising incidences of diabetes worldwide. The clinical presentation of DPN includes symmetrical limb pain, especially at the end of the limbs, often characterized as a gloves-and-socks sensation [1]. Diabetic peripheral neuropathy is associated with higher mortality, diminished quality of life, and serious complications like foot ulcers and amputations. It also places a significant economic burden on healthcare systems and reduces workforce productivity [5]. To minimize the significant Disability-Adjusted Life Year (DALY) burden from diabetic peripheral neuropathy, it is crucial to integrate structured screening protocols for early detection at the primary care level.

The diagnosis of diabetic peripheral neuropathy is quite challenging because of the lack of specific and universally accepted diagnostic criteria. Although nerve conduction studies (NCS) are considered the gold standard, their use is hampered by the fact that they require special equipment and trained personnel. Because of this, they do not apply to screening under all circumstances [6]. The Michigan Neuropathy Screening Instrument (MNSI), which allows for early detection and referral for electromyography when necessary, is a simple, valid, and reliable way to evaluate diabetic peripheral neuropathy in diabetic patients at the primary care level [7]. MNSI has a sensitivity of 80% and specificity of 95% [7, 8].

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Received: March 11, 2026; Revised: June 18, 2026; Accepted: July 20, 2026
DOI: https://doi.org/10.37184/lnjpc.2707-3521.8.70

A survey of 1003 people with type 2 diabetes in Jordan found that the overall diabetic peripheral neuropathy prevalence was 39.5%, with numbness and pain during walking being the common symptoms. The study identified correlations between diabetic peripheral neuropathy and long-standing diabetes, dyslipidemia, diabetic retinopathy, and unemployment, highlighting an urgent need for targeted interventions in high-risk groups [9]. A multicentric cross-sectional study conducted in rural regions of India reported a prevalence of diabetic peripheral neuropathy of 39.3%. (28.9% males and 10.4% females). The existence of diabetic peripheral neuropathy was substantially correlated with age, sex, length of diabetes, HbA1c value, hypertension, and BMI [10].

In Pakistan, a meta-analysis found the prevalence of diabetic peripheral neuropathy among patients with diabetes was 43.16%, varying provincially: 55.29% in Khyber Pakhtunkhwa, 40.04% in Sindh, followed by Punjab having the lowest prevalence of 34.90% [11]. In contrast, the prevalence of diabetic peripheral neuropathy was reported much higher (79.5%) in a survey carried out in Peshawar. This could be attributed to the study being conducted in an Endocrinology clinic of a tertiary care hospital where patients with more advanced diseases are likely to present [6]. There is a dearth of data from primary care settings which handle the bulk of patients with diabetes. This study was therefore undertaken to determine the frequency and associated factors of diabetic peripheral neuropathy in patients with type 2 diabetes visiting primary care clinics in Karachi. The findings of the study may support the development of feasible, context-appropriate screening models for integration into primary care diabetes management protocols.

METHODOLOGY

This cross-sectional study was executed at the Family Medicine clinics of Liaquat National Hospital and its community-based outreach centers located in Shah Faisal, Gulshan-e-Iqbal, and Gulistan-e-Jauhar, Karachi, Pakistan. The study was performed from 1st December 2024 to 30th June 2025. The study commenced after obtaining approval from the Hospital Ethics Committee on institutional letterhead bearing number Ref: App#1104-2024-LNH-ERC. Adults aged 18 years or above visiting primary care clinics with a confirmed diagnosis of T2DM (HbA1C >6.5%) according to American Diabetes Association guidelines 2024 [12], in addition to the self-reported use of antidiabetic medication, and verification from patients' medical records, and those who were willing to participate were included. Patients with a history of nerve root compression, hypothyroidism, cerebrovascular disease, and those unable to reliably report symptoms due to neurological disorders or cognitive impairment were excluded to avoid diagnostic confounding and unreliable clinical assessment, as supported by a literature review [6].

A sample size of 242 patients was estimated, using a 65.5% prevalence of diabetic peripheral neuropathy (DPN) from a previous study [6], a 95% confidence interval, and a 6% margin of error. The online calculator OpenEpi was used with the single population proportion option to perform the calculation. Participants were enrolled with their written informed consent through a non-probability consecutive sampling method, including all eligible patients who presented during the study period.

The diabetic peripheral neuropathy assessment was done by physician trainees who were trained to perform standardized foot examination before the commencement of data collection. Participants who met the inclusion criteria were enrolled, and the questionnaire was completed after obtaining informed consent—the study questionnaire comprised three sections: demographic profile, clinical profile, and MNSI tool. The MNSI has two steps. The questionnaire examining clinical symptoms is used to evaluate the occurrence of symptoms indicating the presence of diabetic peripheral neuropathy (DPN). There are 15 questions in total, of which 13 are related to neuropathy symptoms. Question number 4 assesses impaired circulation (peripheral vascular disease), and item 10 evaluates general asthenia; thus, these two questions are eliminated from the final score. A "Yes" response to questions 1-3, 5-6, 8-9, 11-12, and 14-15 is given one point, whereas a "No" response to questions 7 and 13 is given one point. The total score varies from 0 up to 13 points, and the 7-point threshold is used to ascertain the presence of neuropathy symptoms indicating diabetic peripheral neuropathy. The physical examination of the feet is the second step of the MNSI tool. Each foot was examined for any abnormality such as dry skin, calluses, or infections; the presence of any ulceration; vibration sense was examined using a tuning fork at 128 Hz; the ankle reflex was examined using a reflex hammer; and fine touch sensation was tested using a 10-g Semmes-Weinstein monofilament. Patients are classified as having diabetic peripheral neuropathy if they receive more than two points on a 10-point scale in the examination part of the MNSI. Overall diabetic peripheral neuropathy frequency was defined as positive if neuropathy was identified by either self-reported symptoms (MNSI questionnaire score ≥7), physical examination (MNSI examination score >2), or both.

Data were entered into SPSS version 27 for statistical analysis. Frequencies and percentages were computed for categorical variables. Numerical variables were summarized as mean ± standard deviation or median with interquartile range as appropriate. The assumption of normality was tested using the Shapiro-Wilk test. Poisson regression with a log link function and robust estimation was applied to compute prevalence ratios to determine the association of patients' features with diabetic peripheral neuropathy. This approach was

specifically chosen because of high DPN prevalence (56.5%), allowing for direct estimation of prevalence ratios. Variables with p-value <0.25 in univariate analysis were entered into the final regression model. The statistical significance in the final regression analysis was $p < 0.05$. Model fit was assessed using the deviance and Pearson chi-square goodness-of-fit statistics.

RESULTS

Overall, 260 patients were studied, with a mean age of 53.5 ± 11.7 years (range 21-88). About one-third (33.5%) were aged ≥ 60 years. Males made up 59.6% of participants. Nearly two-thirds (60%) had completed graduation or higher education, while 59.2% were employed and 26.2% were homemakers. Smoking was reported by 28.1% of participants, while alcohol use was uncommon (2.7%) (**Table 1**).

Table 1: Summary of sociodemographic features of study participants.

Variables	Groups	Frequency	Percentage
Age	21-29 years	11	4.2
	30-39 years	22	8.5
	40-49 years	55	21.2
	50-59 years	85	32.7
	60 years and above	87	33.5
Gender	Male	155	59.6
	Female	105	40.4
Education	Illiterate	15	5.8
	Madrasa	6	2.3
	Primary	15	5.8
	Secondary	16	6.2
	Matric	15	5.8
	Inter	36	13.8
	Graduate	105	40.4
	Postgrad	51	19.6
	Any other	1	0.4
Employment	Employed	154	59.2
	Unemployed	38	14.6
	Home maker	68	26.2
Addiction	Smoking	73	28.1
	Alcohol	7	2.7

Table **2** summarizes clinical features. The mean disease duration was 7.5 ± 3.8 years, and average body mass index was 27.1 ± 3.7 kg/m². About 41% of patients had diabetes for 5-10 years, and 29% for more than 10 years. Most participants (88.8%) had good glycemic control. 60 % had a lipid profile test within the last 3 months. Nearly 37% had a foot examination, and 40% underwent retinopathy screening within the previous year. About one-quarter of patients (25%) visited their doctor every 5-6 months, whereas 35% visited 6-8 months (**Table 2**).

Table 2: Summary of clinical features of patients.

Variables	Groups	Frequency	Percentage
Disease duration	<5 years	78	30.0
	5-10 years	106	40.8
	>10 years	76	29.2
Current glycemic status	Good (HbA1c ≤7%)	231	88.8
	Poor (HbA1c >7%)	29	11.2
Have you got your lipid profile tested in the last 3 months?	yes	156	60.0
	no	104	40.0
Frequency of doctor visits for DM consultation?	every 3-4 months	61	23.5
	Every 4-5 months	44	16.9
	Every 5-6 monthly	65	25.0
	Every 6-8 monthly	90	34.6
Diabetic foot exam done within a year?	yes	96	36.9
	no	164	63.1
Diabetic retinopathy screening done within a year?	yes	105	40.4
	no	155	59.6

Nearly half of the participants (49.2%) reported numbness of legs or feet, and 45% experienced burning pain. Muscle cramps were common (62.7%), while about 39% had prickling sensations. A smaller proportion (15.8%) found their feet too sensitive to touch, and 16% reported open sores. Only 2% had undergone amputation (**Table 3**). Frequency of diabetic peripheral neuropathy based on clinical history was seen in 19.2% (**Table 3**). Patients with a history of clinical symptoms were significantly more likely to have DPN confirmed by physical examination than those without symptoms (92.0% *vs.* 28.9%, $p < 0.001$) (**Table 4**).

Table 3: Frequency distribution of clinical history questions and DPN burden based on clinical history.

Clinical History Items	Yes n(%)	No n(%)
Are your legs and/or feet numb?	128(49.2)	132(50.8)
Do you ever have any burning pain in your legs and/or feet?	118(45.4)	142(54.6)
Are your feet too sensitive to touch?	69(26.5)	191(73.5)
Do you get muscle cramps in your legs and/or feet?	163(62.7)	97(37.3)
Do you ever have any prickling feelings in your legs or feet?	113(43.5)	147(56.5)
Does it hurt when the bed covers touch your skin?	41(15.8)	219(84.2)
When you get into the tub or shower, are you able to tell the hot water from the cold water?	205(78.8)	55(21.2)
Have you ever had an open sore on your foot?	41(15.8)	219(84.2)
Has your doctor ever told you that you have diabetic neuropathy?	57(21.9)	203(78.1)
Do you feel weak all over most of the time?	138(53.1)	122(46.9)
Are your symptoms worse at night?	102(39.2)	158(60.8)
Do your legs hurt when you walk?	85(32.7)	175(67.3)
Are you able to sense your feet when you walk?	212(81.5)	48(18.5)
Is the skin on your feet so dry that it cracks open?	96(37)	164(63)
Have you ever had an amputation?	5(1.9)	255(98.1)

Clinical History Items	Yes n(%)	No n(%)
DPN based on clinical history	**n**	**percentage**
Yes	50	19.2
No	210	80.8

Table 4: Comparison of DPN freq\uency of physical examination with DPN found on clinical symptoms history.

DPN Based on Clinical Symptoms History	DPN Based on Physical Examination	
	Yes n(%)	No n(%)
yes	97(46.2)	4(8)
no	46(92)	113(53.8)

Table 5: Frequency distribution of physical examination based on MNSI Instrument and DPN burden based on physical examination.

Physical Examination Items	Right Feet n(%)	Left Feet n(%)
Normal appearance of feet	163(62.7)	161(61.9)
Absence of ulceration	231(88.8)	237(91.2)
Presence of ankle reflexes	151(58.1)	145(55.8)
Presence of vibration perception at great toe	128(49.2)	135(51.9)
Normal monofilament	158(60.8)	144(55.4)
DPN based on physical examination	**n**	**percentage**
Yes	143	55.0
No	117	45.0

On examination, the majority had normal foot appearance and no ulceration. However, ankle reflexes were present in only 58%, and vibration perception at the great toe was normal in about half. Monofilament testing was normal in 56-61% of feet. Frequency of diabetic peripheral neuropathy based on the MNSI tool was seen in 55% (**Table 5**).

The overall prevalence of diabetic peripheral neuropathy combining clinical history and physical examination based on the MNSI tool was 56.5%. On univariate analysis, participants aged < 50 years were significantly less likely to have diabetic peripheral neuropathy than those aged ≥ 50 years (PR=0.70, 95% CI: 0.58-0.83, p<0.001). Lower education levels were also associated with higher prevalence of DPN, particularly among participants who received no formal education (PR=1.83, 95% CI: 1.04-3.23, p=0.037). Shorter duration of diabetes (<10 years) and lower BMI categories were both significantly protective factors (p < 0.001) (**Table 6**).

In the multivariable model, after adjusting for potential confounders, only disease duration and body mass index remained significantly associated with DPN. Patients with diabetes duration < 5 years had markedly

Table 6: Univariate and multivariable association of patients' features with DPN.

Variables	Groups	Yes	No	PR(95% CI)	p-value	aPR(95% CI)	p-value
Age	<50 years	27(30.7)	61(69.3)	0.70(0.58-0.83)	**<0.001	0.71(0.44-1.18)	0.0193
	≥50 years	120(69.8)	52(30.2)	Reference category		Reference category	
Gender	Male	89(57.4)	66(42.6)	0.55(0.43-0.72)	0.818	-	-
	Female	58(55.2)	47(44.8)	Reference category		-	-
Education	Illiterate	14(93.3)	1(6.7)	1.83(1.04-3.23)	*0.037	0.95(0.49-1.81)	0.876
	Madrasa	5(83.3)	1(16.7)	1.63(0.66-4.04)	0.286	1.07(0.42-2.72)	0.883
	Primary to secondary	22(71)	9(29)	1.39(0.86-2.32)	0.169	0.86(0.41-1.82)	0.567
	Matric	8(53.3)	7(46.7)	1.04(0.51-2.16)	0.902	0.86(0.52-1.43)	0.697
	Intermediate	18(50)	18(50)	0.98(0.58-1.63)	0.942	0.88(0.52-1.49)	0.647
	Graduation and above	80(51)	77(49)	Reference category		Reference category	
Employment status	Employed	74(48.1)	80(51.9)	0.71(0.49-1.02)	0.069	0.81(0.31-1.56)	0.356
	Unemployed	27(71.1)	11(28.9)	1.05(0.65-1.68)	0.839	0.91(0.53-1.56)	0.740
	Homemaker	46(67.6)	22(32.4)	Reference category		Reference category	
Addiction	Smoker	48(65.8)	25(34.2)	1.24(0.88-1.75)	0.218	1.23(0.83-1.87)	0.280
	Alcohol	6(85.7)	1(14.3)	1.53(0.67-3.48)	0.302	-	-
Duration	<5 years	22(28.2)	56(71.8)	0.32(0.20-0.53)	**<0.001	0.47(0.26-0.85)	*0.012
	5-10 years	59(55.7)	47(44.3)	0.64(0.45-0.91)	*0.013	0.72(0.50-1.07)	0.105
	>10 years	66(86.8)	10(13.2)	Reference category		Reference category	
Body mass index	Normal	27(33.8)	53(66.3)	0.40(0.25-0.65)	**<0.001	0.51(0.31-0.86)	*0.012
	Overweight	75(59.5)	51(40.5)	0.71(0.49-1.03)	0.074	0.75(0.51-1.12)	0.162
	Obese	45(83.3)	9(16.7)	Reference category		Reference category	
Doctor visit	every 3-4 months	29(47.5)	32(52.5)	0.82(0.52-1.29)	0.400	-	-
	Every 4-5 months	24(54.5)	20(45.5)	0.94(0.58-1.53)	0.816	-	-
	Every 5-6 months	42(64.6)	23(35.4)	1.12(0.75-1.67)	0.590	-	-
	Every 6-8 months	52(57.8)	38(42.2)	Reference category		Reference category	
Foot examination done within a year	Yes	59(61.5)	37(38.5)	1.14(0.82-15.9)	0.420	-	-
	No	88(53.7)	76(46.3)	Reference category		Reference category	
Glycemic status	Good	129(55.8)	102(44.2)	0.65(0.32-0.91)	*0.029	0.58(0.41-1.43)	0.834
	Poor	18(62.1)	11(37.9)	Reference category		Reference category	

CI: Confidence interval, PR= prevalence ratio, aPR= Adjusted prevalence ratio, *Significant at p<0.05, **Significant at p<0.01
Model fit statistics: Loglikelihood=-212.44, Deviance=130.88 (df=246, Deviance/df=0.53), Pearson Chi-square=109.87(df=246, Pearson χ^2/df = 0.45), Akaike's Information Criterion (AIC)=452.88

lower prevalence of DPN compared with those with > 10 years (PR=0.47, 95% CI: 0.26-0.85, p=0.012). Similarly, patients with normal BMI had reduced prevalence of DPN compared with obese individuals (PR=0.51, 95% CI: 0.31-0.86, p=0.012). No significant associations were found for gender, education, employment, smoking, alcohol use, or glycemic status after adjustment (**Table 5**).

DISCUSSION

The frequency of diabetic peripheral neuropathy (DPN) in our study was 55%, comparable to reports from Ethiopia (53.6%) [13] and India (59.1%) [14]. This similarity may partly be explained by the use of comparable screening tools (MNSI) and study methodologies. Lower frequencies have been documented in studies from Saudi Arabia (39%) [15] and Qatar (22%) [16]; the latter reported lower prevalence in primary care (14.8%) compared with secondary care settings (23.9%), likely reflecting differences in case complexity and referral patterns [16]. In contrast, higher frequencies have been observed in tertiary care-based studies, such as a survey conducted in an endocrinology setup at Peshawar reporting a diabetic peripheral neuropathy frequency of 79.5%6 and a study from Iran reporting a prevalence of 64.6% [17]; the latter likely reflecting the inclusion of hospitalized patients with more advanced disease. A multinational INTERPRET-DD study, conducted across 14 countries, reported a lower overall prevalence of 26.7%. However, substantial inter-country variation was noted, with higher rates observed in Ukraine (79.5%) and Russia (54.7%), followed by Pakistan (39.8%) [18]. These findings highlight the heterogeneity of diabetic peripheral neuropathy prevalence across regions. Variations likely influence these estimates in study design, clinical settings, patient characteristics, screening tools used, and healthcare delivery systems.

The marked discrepancy noted between diabetic peripheral neuropathy frequencies identified through MNSI-based physical examination (55%) and a self-reported patient history (19.2%) is concerning and suggests substantial underestimation of diabetic peripheral neuropathy when relying solely on self-reporting. Similar trends have been reported by Karttiksaravanan [19] and Khawaja *et al.* [9], who observed lower diabetic peripheral neuropathy frequencies based on symptom history (16.5%) compared with higher rates detected through physical examination (21.8% and 34.8%, respectively). However, EsnaAshari *et al.* [17] reported similar frequencies of diabetic peripheral neuropathy based on physical examination (75.9%) and self-reported symptoms (72.8%), with a slight difference between the two assessment methods. Although the frequencies of diabetic peripheral neuropathy by clinical symptoms in earlier studies showed lower results [9, 19], the magnitude of the difference in our study is much higher. This may be due to population-specific variables such as health literacy and symptom awareness. Although 60% of our participants had graduate-level education, this does not necessarily indicate adequate health literacy. Many may still lack sufficient awareness of the disease, recognition of symptoms, and appropriate health-seeking behavior. Such underestimation is probably multifactorial. Patients may become accustomed to mild neuropathic symptoms and perceive them as natural effects of diabetes and not necessarily know about diabetic peripheral neuropathy. Other associated factors may include cultural factors, the lack of physician-patient interaction in the busy outpatient setting, and the lack of attention to neuropathy education in general diabetes education. Altogether, a consistently lower frequency of diabetic peripheral neuropathy detected with the help of patient self-reported symptom history should highlight the questionable reliability of the given method when applied without a physical examination. It also emphasizes the significance of physical examination as a mandatory element of diabetic peripheral neuropathy screening in a regular healthcare facility.

Longer duration of diabetes was found to be independently associated with diabetic peripheral neuropathy in our study, in line with findings from multiple international reports [13, 20]. Over the long term, chronic hyperglycemia destroys nerves in the following ways: oxidative stress, generation of end-products of advanced glycation, activation of the polyol pathway, and inadequate microvascular blood perfusion [21]. Patients with diabetes for over ten years had nearly nine times the odds of developing diabetic peripheral neuropathy. This finding underscores the paramount importance of early detection and timely, comprehensive management. With 41% of participants diagnosed with diabetes for 5-10 years and 29% for over a decade, many are likely to develop silent nerve damage long before diagnosis. This highlights the critical need for early and proactive screening of diabetic peripheral neuropathy in routine diabetic care at the primary care level.

In univariate analysis, we found a strong association between age and the presence of diabetic peripheral neuropathy, with those under 50 years being less likely to have neuropathy. This finding is consistent with evidence indicating that increasing age is associated with cumulative levels of metabolic exposure and increasing nerve damage. A multivariate analysis of the effect of this damage, controlling for the effect of the latter, revealed no significant relationship between persistent hyperglycemia and neuropathy [4]. Despite this association being influenced by longer disease duration and associated co-morbid conditions, large multinational trials and meta-analyses have consistently identified increasing age as a major factor in developing diabetic peripheral neuropathy [18].

The male predominance observed in our study (59.6%) is consistent with the gender distribution typically seen in diabetes clinic-based populations and may reflect differences in health-seeking behaviors. However,

after adjustment for this imbalance, gender itself was not independently associated with diabetic peripheral neuropathy, in keeping with findings from most large-scale epidemiological studies [18].

We observed that diabetic peripheral neuropathy was inversely related to level of education in univariate analysis; however, this association disappeared in the multivariate model. Lower educational attainment may reflect reduced health literacy, suboptimal self-care practices, and delayed health-seeking behaviors, as reported in studies from primary and secondary care settings in Qatar and South Asia [16, 20]. This loss of association suggests that biological factors, especially longer disease duration and obesity, have a greater impact on diabetic peripheral neuropathy risk in our population.

In the current study, no noteworthy link was seen between employment status and the presence of diabetic peripheral neuropathy after multivariable adjustment, which aligns with the findings of Kamalarathnam *et al.* [22]. In contrast, Khawaja *et al.* [9] found higher odds of DPN in unemployed patients even after multivariable adjustment. Differences between studies may reflect variations in study populations, reference categories for employment, and covariates included in the models. In our analysis, the initial univariate association was largely explained by factors such as age, diabetes duration, comorbidities, and glycemic control.

Chronic tobacco exposure contributes to endothelial dysfunction, oxidative stress, microvascular impairment, and reduced nerve blood flow, which can contribute to nerve damage in diabetes [23]. Alcohol consumption has also appeared as a risk factor in several studies, though findings vary depending on how exposure is measured and controlled [24]. In our study, the odds of diabetic peripheral neuropathy were higher in smokers and alcohol users, but it did not achieve statistical significance. This lack of significance is likely due to the small proportion of smokers (28.1%) and alcohol users (2.7%), which limited the statistical power to detect a true effect.

Higher BMI was independently associated with higher odds of diabetic peripheral neuropathy (aOR for normal to obese group: 0.11; p <0.001), linking obesity to long-term diabetes complications. In our study, the average BMI was 27.1 ± 3.7 kg/m2, indicating that most participants were overweight or obese. The relationship between obesity and neuropathy is multifactorial. This involves insulin resistance, chronic low-grade inflammation, dyslipidemia, and possibly mechanical pressure on peripheral nerves. According to the Maastricht Study, neuropathic patients with type 2 diabetes were notably less active and more sedentary, reinforcing the critical role of lifestyle in diabetic peripheral neuropathy risk [25]. These findings emphasize weight management as a vital strategy to lower diabetic peripheral neuropathy risk and support its integration into routine diabetes care.

Interestingly, even though nearly 89% of our study participants had good glycemic control, diabetic peripheral neuropathy remained highly prevalent. One possible explanation is the residual effects of past poor glucose control. The finding may also reflect the limitations of relying only on HbA1c, which does not capture glucose fluctuations or post-meal spikes, and the complex, multifactorial nature of diabetic peripheral neuropathy involving both metabolic and inflammatory factors. Measurement or recall biases may also contribute to patient self-reported glucose readings. We observed that good glycemic control was significantly associated with lower odds of developing diabetic peripheral neuropathy in the univariate analysis. However, this effect disappeared after adjustment, highlighting the challenges of assessing risk using a single-time glucose measurement, a finding consistent with other cross-sectional studies [26].

One of the alarming findings of our study is the substantial gap in routine diabetes care. In our study, less than 40% of the participants received annual foot examination or retinopathy screening. Such deficiencies in preventive care are commonly reported in developing countries. These deficiencies can lead to delayed recognition and progression of diabetic complications, including diabetic peripheral neuropathy [4, 11]. These findings highlight an urgent need to strengthen primary care-based screening, ensure regular metabolic monitoring, and establish structured follow-up systems for early detection and management of diabetic neuropathy.

This study has several important strengths, one of the major ones being its setting. Notably, it is among the few conducted at the primary care level, which allows it to more accurately reflect the burden of diabetic peripheral neuropathy in primary care settings in Karachi, Pakistan. The use of a validated screening tool that integrates symptom assessment with objective clinical examination enhances the sensitivity of diabetic peripheral neuropathy detection in our study.

LIMITATIONS

This study has certain limitations. The use of a cross-sectional design has its constraints because it cannot be used to establish causal relationships between the associated factors and diabetic peripheral neuropathy. The sample size computed for this study, based on the estimated frequency of DPNs, may not be large enough for regression analysis. Therefore, it is important to view the associations found in this study with caution. In addition, the use of non-probability consecutive sampling from selected primary-care clinics and outreach centers may limit the generalizability of the findings. Participants attending healthcare facilities may differ from community-dwelling individuals with T2DM who do not seek regular care, and the relatively high educational status of the

study population may not be representative of the broader diabetic population in Karachi or Pakistan. Also, a single-time HbA1c measurement may not truly reflect long-term glycemic control. Important variables such as hypertension, dyslipidemia, medication use, and other diabetic complications were not available and could not be included, which may have introduced residual confounding. Finally, absence of measurement of vitamin B12 levels may have introduced misclassification bias, as undiagnosed B12 deficiency among study participants may have contributed to an overestimation of DPN in our study.

CONCLUSION

Our research found high rates of diabetic peripheral neuropathy in primary care clinics, particularly among those with longer disease duration and patients with elevated BMI, emphasizing continuous surveillance and timely management for strengthening community-level care.

ETHICS APPROVAL

Ethical approval was obtained from Ethics Committee of Liaquat National Hospital (Ref: App#1104-2024-LNH-ERC). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and the Declaration of Helsinki.

CONSENT FOR PUBLICATION

All participants provided written informed consent before they were involved in the study.

AVAILABILITY OF DATA

All data generated or analyzed during this study are available from the corresponding author upon reasonable request.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

We would like to acknowledge Ms. Sumaiya Khuwaja, who was involved in data collection.

AUTHORS' CONTRIBUTION

Fatima Asghar conceived the study, developed the study protocol, and drafted the manuscript. Rabeeya Saeed contributed to protocol design and critically reviewed the initial manuscript draft. Noreen Durrani performed the statistical analysis and contributed to result interpretation and manuscript writing. Aleena Amjad was involved in data collection, analysis, and methodology writing.

All authors reviewed and approved the final version of the manuscript.

REFERENCES

1. Yang K, Wang Y, Li YW, Chen YG, Xing N, Lin HB, *et al.* Progress in the treatment of diabetic peripheral neuropathy. Biomed Pharmacother 2022; 148: 112717.
DOI: https://doi.org/10.1016/j.biopha.2022.112717
2. Wu B, Niu Z, Hu F. Study on risk factors of peripheral neuropathy in type 2 diabetes mellitus and establishment of prediction model. Diabetes Metab J 2021; 45(4): 526-38.
DOI: https://doi.org/10.4093/dmj.2020.0100
3. Azeem S, Khan U, Liaquat A. The increasing rate of diabetes in Pakistan: a silent killer. Ann Med Surg (Lond) 2022; 79: 103901.
DOI: https://doi.org/10.1016/j.amsu.2022.103901
4. Hicks CW, Selvin E. Epidemiology of peripheral neuropathy and lower extremity disease in diabetes. Curr Diab Rep 2019; 19(10): 86.
DOI: https://doi.org/10.1007/s11892-019-1212-8
5. Fakkel TM, Çakici N, Coert JH, Verhagen AP, Bramer WM, van Neck JW. Risk factors for developing diabetic peripheral neuropathy: a meta-analysis. SN Compr Clin Med 2020; 2(10): 1853-64.
DOI: https://doi.org/10.1007/s42399-020-00480-0
6. Hussain A, Ahmad I, Khan MN, Zar A, Shahzad S. Peripheral neuropathy among patients with type 2 diabetes using Michigan neuropathy screening instrument. J Postgrad Med Inst 2021; 35(1): 7-11.
DOI: https://doi.org/10.54079/jpmi.35.1.2735
7. Moghtaderi A, Bakhshipour A, Rashidi H. Validation of Michigan neuropathy screening instrument for diabetic peripheral neuropathy. Clin Neurol Neurosurg 2006; 108(5): 477-81.
DOI: https://doi.org/10.1016/j.clineuro.2005.08.003
8. Herman WH, Pop-Busui R, Braffett BH, Martin CL, Cleary PA, Albers JW, *et al.* Use of the Michigan Neuropathy Screening Instrument as a measure of distal symmetrical peripheral neuropathy in type 1 diabetes: results from the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications. Diabet Med 2012; 29(7): 937-44.
DOI: https://doi.org/10.1111/j.1464-5491.2012.03644.x
9. Khawaja N, Abu-Shennar J, Saleh M, Dahbour SS, Khader YS, Ajlouni KM. The prevalence and risk factors of peripheral neuropathy among patients with type 2 diabetes mellitus: the case of Jordan. Diabetol Metab Syndr 2018; 10: 8.
DOI: https://doi.org/10.1186/s13098-018-0309-6
10. Darivemula S, Nagoor K, Patan SK, Reddy NB, Deepthi CS, Chittooru CS. Prevalence and its associated determinants of diabetic peripheral neuropathy in individuals having type 2 diabetes mellitus in rural South India. Indian J Community Med 2019; 44(2): 88-91.
11. Akhtar S, Hassan F, Saqlain SR, Ali A, Hussain S. The prevalence of peripheral neuropathy among patients with diabetes in Pakistan: a systematic review and meta-analysis. Sci Rep 2023; 13(1): 11744.
DOI: https://doi.org/10.1038/s41598-023-39037-1
12. American Diabetes Association Professional Practice Committee; 2. Diagnosis and Classification of Diabetes: Standards of Care in Diabetes—2024. Diabetes Care 2024; 47(Supplement_1): S20-S42.
DOI: https://doi.org/10.2337/dc24-S002
13. Abdissa D, Hamba N, Kene K, Bedane DA, Etana G, Muleta D, *et al.* Prevalence and determinants of peripheral neuropathy among type 2 adult diabetes patients attending Jimma University Medical Center, Southwest Ethiopia, 2019, an institutional-based cross-sectional study. J Diabetes Res 2020; 2020: 9562920.
DOI: https://doi.org/10.1155/2020/9562920
14. Chakraborty S, Majumder A. Prevalence and correlates of peripheral neuropathy amongst type 2 diabetes mellitus patients-a community-based epidemiological study in a town of Eastern India. J Med Evid 2023; 4(2): 130-5.
DOI: https://doi.org/10.4103/JME.JME_26_22

15. Owolabi LF, Alghamdi M, Adamu B, Taura MG, Jibo A, Almansour M, *et al.* Magnitude of diabetic peripheral neuropathy in Saudi Arabia: a systematic review and meta-analysis. BMC Endocr Disord 2022; 22(1): 266.
DOI: https://doi.org/10.1186/s12902-022-01167-4

16. Ponirakis G, Elhadd T, Chinnaiyan S, Hamza AH, Sheik S, Kalathingal MA, *et al.* Prevalence and risk factors for diabetic neuropathy and painful diabetic neuropathy in primary and secondary healthcare in Qatar. J Diabetes Investig 2021; 12(4): 592-600.
DOI: https://doi.org/10.1111/jdi.13388

17. EsnaAshari P, Mianehsaz E, Afarini M, Azadchehr MJ. Assessing diabetic polyneuropathy prevalence in hospitalized patients: a comparative study using the Michigan Self-Report Questionnaire and physical examination methods. J Diabetes Investig 2025; 16: 7027972.
DOI: https://doi.org/10.1155/jdr/7027972

18. Lu Y, Xing P, Cai X, Luo D, Li R, Lloyd C, *et al.* Prevalence and risk factors for diabetic peripheral neuropathy in type 2 diabetic patients from 14 countries: estimates of the INTERPRET-DD study. Front Public Health 2020; 8: 534372.
DOI: https://doi.org/10.3389/fpubh.2020.534372

19. Karthiksaravanan K, Meriton AS. A study on prevalence of diabetic peripheral neuropathy in diabetic patients attending a rural health and training centre. J Family Med Prim Care 2024; 13(2): 726-9.
DOI: https://doi.org/10.4103/jfmpc.jfmpc_709_23

20. Tahir M, Adil M, Khalid SR, Khan S, Tariq SB. Prevalence and risk factors for diabetic peripheral neuropathy among type 2 diabetes mellitus patients. Prof Med J 2020; 27(9): 1885-90.
DOI: https://doi.org/10.29309/TPMJ/2020.27.09.4239

21. Liu Z, Zhou L, Zhao W, Jin L, Zhang J, Zhang Y, *et al.* Predict and prevent microvascular complications of type 2 diabetes: a cross-sectional and longitudinal study in Chinese communities. Front Endocrinol (Lausanne) 2025; 16: 1541663.
DOI: https://doi.org/10.3389/fendo.2025.1541663

22. Kamalarathnam SR, Varadarajan S. Diabetic peripheral neuropathy in diabetic patients attending an urban health and training centre. J Family Med Prim Care 2022; 11(1): 113-7.
DOI: https://doi.org/10.4103/jfmpc.jfmpc_470_21

23. Liu Z, Zhou L, Zhao W, Jin L, Zhang J, Zhang Y, *et al.* Predict and prevent microvascular complications of type 2 diabetes: a cross-sectional and longitudinal study in Chinese communities. Front Endocrinol (Lausanne) 2025; 16: 1541663.
DOI: https://doi.org/10.3389/fendo.2025.1541663

24. Zhou P, Zhou JS, Li JJ, Qin L, Hu WF, Zhang XY, *et al.* Prevalence and risk factors for painful diabetic peripheral neuropathy: a systematic review and meta-analysis. Front Neurol 2025; 16: 1564867.
DOI: https://doi.org/10.3389/fneur.2025.1564867

25. Ahaouari T, Berendsen B, Schaper N, Bosma H, van Greevenbroek M, de Galan B, *et al.* Combined associations of type 2 diabetes and peripheral neuropathy with device-measured physical activity and sedentary behaviour—the Maastricht Study. Diabetes Metab Res Rev 2025; 41(5): e70069.
DOI: https://doi.org/10.1002/dmrr.70069

26. Liu X, Xu Y, An M, Zeng Q. The risk factors for diabetic peripheral neuropathy: a meta-analysis. PLoS One 2019; 14(2): e0212574.
DOI: https://doi.org/10.1371/journal.pone.0212574