RESEARCH PAPER

Examination-defined diabetic peripheral neuropathy and its determinants among adults with type 2 diabetes in a South Indian field-practice area: a cross-sectional study

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ABSTRACT

Background: One prevalent, crippling, and underreported side effect of type 2 diabetes mellitus (T2DM) is diabetic peripheral neuropathy (DPN). Primary-care detection has a drawback on situations whereby screening is primarily based on patient-reported symptoms.

Purpose: To determine the prevalence of DPN and determine the determinants related to DPN in adults with T2DM in the field-practice setting in Adichunchanagiri Institute of Medical Sciences, Mandya District, Karnataka.

Methods: It was a cross-sectional research conducted between June 2024 and November 2025 involving 363 adults with T2DM who were selected in three health centres through population proportionate sampling. DPN was assessed using the Michigan Neuropathy Screening Instrument (MNSI). The Diabetes Self-management questionnaire and Morisky Green Levine Scale were used to measure self-care and medication adherence. To examine relationships, chi-square tests, independent-samples t-tests, and binary logistic regression were employed.

Results: The overall prevalence of DPN was 38.6% (140/363; 95% CI: 33.7-43.7%). The MNSI physical examination threshold was positive in 38.3% (139/363), but 0.8% (3/363) was positive in MNSI history-component threshold. The mean diabetes duration was more in the participants with DPN than in those without DPN (6.51 +/- 2.38 vs 6.00 +/- 2.15 years; p = 0.035). Duration of diabetes was the only independent predictor of DPN in multivariate analysis (adjusted odds ratio 1.11 per year; 95% CI: 1.01-1.22; p = 0.036).

Conclusion: Over one-third of T2DM individuals had DPN, which was largely identified by examination and not the symptom-history threshold. Neuropathy screening by routine examination should be a part of primary diabetes care, particularly in patients with a extended time of diabetes.

Keywords: diabetic peripheral neuropathy; type 2 diabetes mellitus; Michigan Neuropathy Screening Instrument, risk factors, prevalence, and primary care.

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1. INTRODUCTION

Type 2 diabetes (T2DM) is a serious and expanding public health concern. According to the International Diabetes Federation, the prevalence of diabetes is rising worldwide and is expected to become a major burden in the future [1]. Diabetes and other metabolic non-communicable illnesses have a significant and varied prevalence among Indian states and population categories, according to the ICMR-INDIAB nationwide cross-sectional survey [2]. Due to these changes, early detection of diabetic complications is now crucial in primary care and field practice settings,

where failure to diagnose and follow up can turn avoidable morbidity into chronic impairment.

One of the most serious long-term consequences of diabetes is diabetic peripheral neuropathy (DPN). It plays a role in sensory loss, neuropathic pain, imbalance, foot ulceration, infection and lower-limb amputation [3,4]. Current guidelines and reviews highlight periodic neuropathy and foot-risk assessment since clinically relevant nerve dysfunction might not be reliably detected by spontaneous symptom reporting alone [5-7]. Thus the practical question of public-health is not how prevalent DPN is, but whether or not simple methods of examination can be used to detect patients who otherwise would not have been detected.

The published estimates of DPN prevalence are quite different due to the variation in population characteristics, diagnostic criteria, duration of diabetes, glycaemic exposure and screening method. Rural and primary-care studies in India and neighbouring countries have repeatedly reported a significant burden of neuropathy and often longer diabetes duration has been found to be a determinant [8-13]. Nevertheless, there is a lack of local data on field-practice locations in the Mandya District, especially data that differentiate symptom-threshold positivity and examination-defined neuropathy with a structured screening tool.

A useful bedside test that combines a formal history with a physical examination of the feet is the Michigan Neuropathy Screening Instrument (MNSI) [14,15]. It is especially applicable in primary-care settings where nerve conduction studies are not a regular practice. The current study was conducted at the chosen health centers in the field-practice site of Adichunchanagiri Institute of Medical Sciences, Mandya District, Karnataka, to ascertain the prevalence of DPN and its causes in individuals with type 2 diabetes.

2. MATERIALS AND METHODS

Reporting, setting and study design.

The study was a cross-sectional study done between June 2024 and November 2025 at the field-practice site of B.G. Nagara, Adichunchanagiri Institute of Medical Sciences, Mandya District, Karnataka. The sample was selected in 3 health centres-Community Health Centre (CHC) Bellur, Primary Health Centre (PHC) Adichunchanagiri and CHC Bindiganavile. Since the service area encompassed both an urban service area and rural service areas, the study is said to be a field-practice-area research and not a pure rural prevalence survey. The reporting has been done in compliance with the STROBE guidelines on cross-sectional studies [16].

Subjects and inclusion criteria.

The selected health-centre diabetes registers comprised individuals with a history of type 2 diabetes who were at least eighteen years old. Diabetes diagnosis was done through existing health-centre records and it was in line with accepted diagnostic frameworks [17]. The respondents had to have lived in the chosen service location at least half a year prior to the data collection. Patients were not included when they had reported alternative causes of neuropathic pain, such as spinal cord damage, cancer-related pain, or post-herpetic neuralgia; lower-limb amputation; use of drugs that have been shown to cause peripheral neuropathy-like symptoms, such as cisplatin, antiretroviral therapy or thalidomide; or during pregnancy/lactation.

Sample size and sampling.

Calculation of the sample size in prevalence studies was done as n = Z2pq/d2. With an expected DPN prevalence of 31.1% of a past rural South Indian study [8], 95 percent confidence and 5 percent absolute precision, 330 was the minimum sample size. The quantity of individuals involved in the final sample was 363 after accounting 10 percent non-response.

Sampling was done proportionally to the population in the three centres. The number of registered T2DM population was 6515. CHC Bellur provided 3250 registered patients, and was assigned 182 participants; PHC Adichunchanagiri provided 1210 registered patients, and was assigned 69 participants; and CHC Bindiganavile provided 2055 registered patients, and was assigned 112 participants. Participants were then systematically sampled after proportional allocation of the citizens on the respective diabetes registers until the centre specific sample size was reached. The participants reported full data in the final analysis (363 participants).

Data collection and variables.

Data was collected by principal investigator through a structured proforma after a written informed consent had been taken. Sociodemographic factors were age, sex, residence/service area, religion, education, occupation, marital status, family type, household income and BPL card status. Clinical variables were duration of diabetes, recent random blood sugar (RBS), HbA1c, comorbidities, treatment modality, documented antidiabetic category of drugs, family history of diabetes and history of foot ulcer. Lifestyle variables comprised of smoking, alcohol consumption, tobacco chewing, diet as well as exercise. Body mass index (BMI), weight, height, and waist-hip ratio were anthropometric measures.

Outcome assessment

The MNSI was used to measure DPN. The history component was used to evaluate neuropathic symptoms and the physical examination component evaluated foot appearance, ulceration, ankle reflexes, vibration perception and monofilament sensation. A 10-g monofilament and tuning fork were used as a part of bedside assessment. As per the study protocol, DPN was defined as being present when MNSI history score was 7/13 and/or physical examination score was 2.5/10 and above [14,15]. The major result was

general DPN condition according to this definition. MNSI history-threshold positivity versus physical examination-threshold positivity was kept to measure screening yield.

Self-care and compliance to medication.

The Diabetes Self-Management Questionnaire (DSMQ), a 16-item survey that assesses food control, exercise, glucose management, and physician consultation, was used to gauge the degree of diabetes self-management behavior [18]. Medication adherence was measured using the four-item Morisky Green Levine Scale (MGLS), with lower scores denoting better medication adherence [19]. Based on the study's scoring system, adherence was separated into adherent and non-adherent categories for analysis.

Reduction of bias and quality.

The same structured proforma and screening protocol was employed in all centres to minimize variability of measurements. Privacy in conducting interviews, standardisation of clinical assessment, and checking of completed forms were used to ensure completeness and internal consistency of the data prior to entry. Since the sampling frame of the study was health-centre diabetes registers, the results are deemed applicable to registered adults in the selected field-practice area using T2DM.

Statistical analysis

Data analysis was done using SPSS version 20. Categorical variables were summarized using frequencies and percentages, whereas continuous variables were summarized using means and standard deviations. 95% confidence intervals were used to determine the prevalence of DPN. The relationships between DPN and categorical variables were ascertained using the chi-square test. Continuous variables were compared using the independent-samples t-test. where the variables were continuous, the estimates of bivariate effects took the form of mean differences; where the variables were categorical (binary), they took the form of odds ratios. Binary logistic regression was used to identify the independent determinants of DPN. The model consisted of the following: age, years of diabetes, HbA1c, BMI, Morisky non-adherence, smoking history and DSMQ mean score. Adjusted odds ratios (AORs), 95 percent confidence and p-values were provided. The statistically significant p-value was assumed to be below 0.05.

Ethical considerations

The study was approved by the Adichunchanagiri Institute of Medical Sciences' Institutional Ethics Committee. (approval no. AIMS/IEC/092/2024; date 2 April 2024). All participants gave informed consent in writing. It ensured the anonymity of study data and limited access to study team. Those having neuropathy or clinically significant results were advised and referred to higher centre for additional examination as needed.

3. RESULTS

The final analysis included 363 adults with T2DM. The study population's baseline sociodemographic features are displayed in Table 1. 51-60 years old made up the largest age group (39.9%), followed by 41-50 years (25.9%) and 61-70 years (23.7%). The proportion of the males was 51.5%. A total of 188 respondents who lived in an urban service area and 175 in rural service areas were incorporated into the sample. Most of the people that responded were married (80.7%), and had a BPL card (77.1%).

Table 1. Sociodemographic characteristics of study participants (n = 363).

Variable	Category	n (%)
Age group, years	<=30	2 (0.6)
	31-40	14 (3.9)
	41-50	94 (25.9)
	51-60	145 (39.9)
	61-70	86 (23.7)
	71-80	20 (5.5)
	>80	2 (0.6)
Sex	Female	176 (48.5)
	Male	187 (51.5)
Residence/service area	Urban service area	188 (51.8)
	Rural service areas	175 (48.2)
Education	No formal education	32 (8.8)
	Class 1-7	122 (33.6)
	High school	97 (26.7)
	PUC/diploma	72 (19.8)

	Graduate and above	40 (11.0)
Marital status	Married	293 (80.7)
	Unmarried/widowed/separated	70 (19.3)
Family type	Nuclear	132 (36.4)
	Joint	109 (30.0)
	Three-generation	122 (33.6)
BPL card status	Yes	280 (77.1)
	No	83 (22.9)

PUC, pre-university course; BPL, below poverty line.

Table 2 summarises the clinical, treatment and life style characteristics. Prevalence of hypertension was 39.7% Majority of the participants were on oral hypoglycaemic agents (79.9%). Metformin (50.1%) was the most commonly recorded treatment-drug category. Medication non-adherence was recorded in 62.5% of participants and 53.7% reported no physical activity.

Table 2. Study participants' clinical, therapeutic, and lifestyle characteristics (n = 363).

Variable	Category	n (%)
Comorbidity	Hypertension	144 (39.7)
	Ischemic heart disease	15 (4.1)
	Thyroid disorder	14 (3.9)
	Other comorbidity	38 (10.5)
Mode of diabetes treatment	Oral hypoglycaemic agents	290 (79.9)
	Insulin	50 (13.8)
	Insulin plus oral hypoglycaemic agents	18 (5.0)
	Other treatment	5 (1.4)
Recorded treatment-drug category	Metformin	182 (50.1)
	Glimepiride	62 (17.1)
	Insulin	60 (16.5)
	DPP4 inhibitor	30 (8.3)
	Glibenclamide	14 (3.9)
	Pioglitazone	6 (1.7)
	None recorded	9 (2.5)
Lifestyle factor	Current smoker	67 (18.5)
	Former smoker	52 (14.3)
	Never smoker	244 (67.2)
	Alcohol use: none	221 (60.9)
	Alcohol use: occasional	95 (26.2)
	Alcohol use: regular	47 (12.9)
	Tobacco chewing	71 (19.6)
	Mixed diet	324 (89.3)
	No physical activity reported	195 (53.7)
Medication adherence	Non-adherent by MGLS	227 (62.5)
Foot-related history	Previous foot ulcer	16 (4.4)

DPP4, dipeptidyl peptidase-4; MGLS, Morisky Green Levine Scale. Treatment-drug categories are presented as recorded in the source proforma and dataset.

The prevalence of DPN according to the MNSI classification is shown in Table 3 and Figure 1. DPN was prevalent in 38.6% (140/363; 95% CI: 33.7-43.7%). The MNSI physical examination threshold was positive in 38.3% (139/363) while the MNSI history-component threshold was positive in 0.8% (3/363).

Table 3. Diabetic peripheral neuropathy prevalence according to MNSI evaluation (n = 363).

MNSI classification	n	%	95% CI
MNSI history-component threshold positive	3	0.8	0.3-2.4
MNSI physical examination threshold positive	139	38.3	33.4-43.4
Overall DPN by study definition	140	38.6	33.7-43.7

Diabetic peripheral neuropathy (DPN) and the Michigan Neuropathy Screening Instrument (MNSI). Confidence intervals were calculated from the observed study counts.

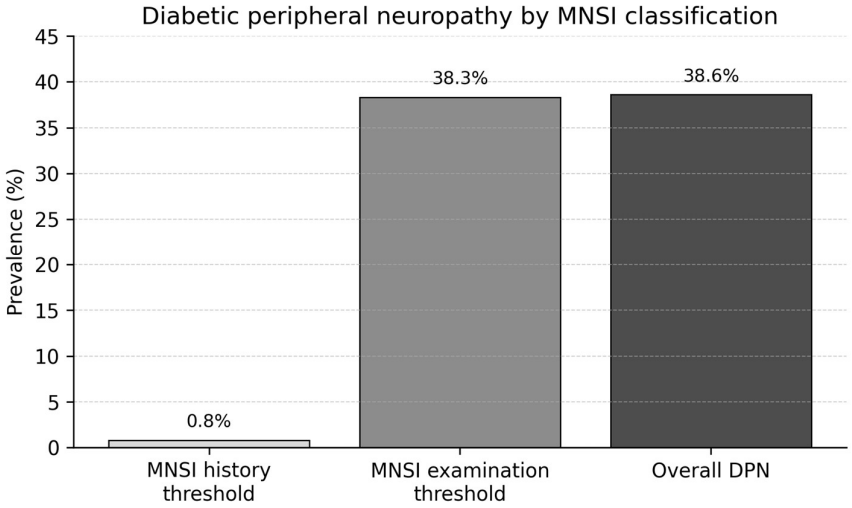

Figure 1. Prevalence of diabetic peripheral neuropathy according to MNSI history threshold, physical examination threshold and overall classification.

MNSI, Michigan Neuropathy Screening Instrument; DPN, diabetic peripheral neuropathy.

The bivariate relationships between specific traits and DPN are displayed in Table 4. The duration of diabetes was substantially longer in those with DPN than in those without (6.51 +/- 2.38 vs. 6.00 +/- 2.15 years; mean difference 0.51 years; 95% CI: 0.02-1.00; p = 0.035). Age, recent RBS, HbA1c, BMI, sex, residence/service area, family history of diabetes, hypertension, smoking status, alcohol usage, physical activity, medication adherence, or history of foot ulcers did not show a statistically significant correlation.

Table 4. Bivariate associations between selected participant characteristics and diabetic peripheral neuropathy.

Variable	Contrast	No DPN (n = 223)	DPN (n = 140)	Effect estimate (95% CI)	p-value
Age, years	Mean difference	55.34 +/- 9.69	55.81 +/- 9.19	0.47 (-1.52 to 2.46)	0.641
Duration of diabetes, years	Mean difference	6.00 +/- 2.15	6.51 +/- 2.38	0.51 (0.02 to 1.00)	0.035
Recent RBS, mg/dL	Mean difference	166.05 +/- 41.22	168.57 +/- 40.84	2.52 (-6.18 to 11.22)	0.570
HbA1c, %	Mean difference	7.17 +/- 1.18	7.23 +/- 1.09	0.06 (-0.18 to 0.30)	0.671
BMI, kg/m2	Mean difference	28.26 +/- 5.58	29.12 +/- 5.12	0.86 (-0.26 to 1.98)	0.138
Sex	Male	111	76	OR 1.20 (0.78 to 1.83)	0.403
Residence/service area	Urban	108	80	OR 1.42 (0.93 to 2.17)	0.106
Family history of diabetes	Present	83	64	OR 1.42 (0.92 to 2.18)	0.108
Hypertension	Present	91	53	OR 0.88 (0.57 to 1.36)	0.576
Smoking status	Current/former/never	41/27/155	26/25/89	Global chi-square test	0.296
Alcohol use	None/occasional/regular	137/57/29	84/38/18	Global chi-square test	0.945
Physical activity	Present	100	68	OR 1.16 (0.76 to 1.77)	0.488
Medication adherence	Non-adherent	145	82	OR 0.76 (0.49 to 1.17)	0.216
History of foot ulcer	Present	7	9	OR 2.12 (0.77 to 5.83)	0.137

For continuous variables, effect estimates are mean differences (DPN minus no DPN). For binary categorical variables, effect estimates are unadjusted odds ratios for DPN. For variables with more than two categories, a global chi-square p-value is reported. RBS, random blood sugar; BMI, body mass index; DSMQ, Diabetes Self-Management Questionnaire.

Table 5. Predictors of diabetic peripheral neuropathy using binary logistic regression.

Predictor	Unit/reference	Adjusted OR (95% CI)	p-value
Age	Per 1-year increase	1.01 (0.983-1.031)	0.552
Duration of diabetes	Per 1-year increase	1.11 (1.01-1.22)	0.036
HbA1c	Per 1% increase	1.04 (0.862-1.24)	0.676
BMI	Per 1 kg/m2 increase	1.03 (0.990-1.071)	0.151
Morisky non-adherence	Non-adherent vs adherent	0.79 (0.46-1.39)	0.421
Smoking history	Ever vs never	1.18 (0.64-2.17)	0.590
DSMQ mean score	Per 1-unit increase	1.05 (0.38-2.88)	0.920

Body mass index (BMI), odds ratio (OR), confidence interval (CI), and diabetes self-management questionnaire (DSMQ). The model included all variables shown in the table.

4. DISCUSSION

This research established that 38.6% of the registered adults with T2DM in a South Indian field-practice region had DPN. The result is also clinically significant as DPN is a significant route towards foot ulceration, infection, disability and preventable amputation [3-7]. The most significant screening finding was that examination-threshold positivity being greater than history-threshold positivity. This is not to be construed as evidence that most of the study participants had no symptoms, yet it is evidence that the number of participants who crossed the predefined MNSI history cutoff was low, and that many participants already had examination-defined neuropathic manifestations. This difference reinforces the need to regularly check the feet and neuropathy in primary diabetes care.

The prevalence observed is widely similar to what has been found in similar environments but also demonstrates why the DPN estimates vary across research. Mathiyalagan et al. found a prevalence of 31.1% at a South Indian rural clinic for non-communicable diseases [8], whereas Darivemula et al. found a lower prevalence in a different study setting and methodology in rural South India [9]. George et al. found 47% prevalence in patients who visit a rural secondary-care hospital in southern India [10], and Katulanda et al. reported 48.1% prevalence in Sri Lanka with the Diabetic Neuropathy Symptom score [12]. Negussie and Bekele on the other hand reported 14.3% in an Ethiopian facility-based study [13]. These comparisons indicate that prevalence is very reliant on case definition, screening tool, patient mix, duration of diabetes and health-system context.

The only independent predictor of DPN was duration of diabetes. This result is biologically plausible since neuropathy is considered cumulative exposure to metabolic and microvascular damage, such as oxidative stress, advanced glycation, endothelial dysfunction, impaired nerve repair, demyelination and axonal degeneration [3,4]. It is also in agreement with rural and primary-care studies that found longer diabetes history to be a predictor of DPN [8,9,12,13]. Despite a small difference in the mean of the duration, the adjusted model demonstrated that an extra year of diabetes raised the odds of DPN by about 11%, which justified risk-stratified screening of patients with a longer illness duration.

In this analysis, HbA1c and recent RBS did not have a significant relationship with DPN, although the evidence of centrality of glycaemic exposure in the pathogenesis of neuropathy is strong [3-6]. This seemingly incongruent result ought to be taken with care. A recent RBS and cross-sectional HbA1c might not reflect the long-term glycaemic exposure, glycaemic variability or previous poor control. On the same note, the lack of statistically significant correlations of BMI, smoking, hypertension, physical activity and medication adherence, cannot be taken as evidence that the variables are clinically irrelevant. Statistical sensitivity may have been compromised by broad exposure categories, self-report, limited dose quantification and residual confounding.

Practical implications to primary care are also found in the study. Foot inspection, monofilament testing, vibration assessment and ankle reflex assessment can be performed in bedside screening and is both cheap and able to identify high-risk patients without the use of specialised electrophysiology. Further evidence of the necessity of organized diabetes education, treatment-adherence counseling, foot-care education and periodic re-assessment of risk is required as there is high rate of medication non-adherence and physical inactivity. Incorporation of DPN screening based on examinations in the routine diabetes follow-up may enhance the detection and referral of diabetics prior to the onset of ulceration.

The strengths of this study are that it has sufficient sample size, population proportionate sampling based on three health centres, it uses a structured screening tool and measures clinical, behavioural and treatment related variables. The research also differentiates between MNSI history-threshold positivity and physical examination-threshold positivity, which is significant in elucidating screening yield in primary-care.

LIMITATIONS

There are shortcomings of this study. To begin with, the cross-sectional design cannot be used to cause an

inference. Second, the sampling frame was registered T2DM patients in the sampled health-centre service areas, thus the results are not to be generalized as the prevalence of all diabetics in the community in Mandya District. Third, the evaluation of DPN was performed through MNSI instead of nerve conduction studies, quantitative sensory exam or small-fibre examination; nevertheless, MNSI is a pragmatic measure to be applied in the field and primary-care. Fourth, clinical and history-based exclusion of other causes of neuropathy had been done but laboratory exclusion of all possible causes, including vitamin B12 deficiency, was not done. Fifth, the variables of lifestyle and adherence were self-reported and may have been impacted by social desirability bias and memory. Lastly, recent RBS and HbA1c might not be cumulative exposure to glycaemia throughout the disease.

FUTURE DIRECTIONS

Prospective designs should be applied in future investigations to estimate incident DPN and whether abnormalities defined by examination early on are predictive of ulceration, decline in disability or quality of life. It would be better to conduct multicentre studies in rural, semi-urban and urban primary-care settings to enhance generalisability. Case ascertainment would be enhanced with diagnostic validation studies that involve MNSI in combination with nerve conduction studies or quantitative sensory testing in a subgroup of patients. Interventional studies are also necessary to determine whether structured foot-care education, adherence support, health-worker training and routine MNSI-based screening can decrease ulceration and delay in referral.

CONCLUSION

In this field-practice-area, more than one-third of patients with Type 2 DM had DPN, highlighting a substantial burden in the study population. Examination-based MNSI screening identified substantially more cases than symptom-threshold screening, suggesting that symptom-based screening alone may miss patients with objective neuropathic manifestations. The only independent predictor observed was longer duration of diabetes. Therefore, regular neuropathy screening should form an integral part of primary care services for diabetic patients, especially those with longstanding diabetes.

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FUNDING STATEMENT

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CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

ETHICS STATEMENT

The Adichunchanagiri Institute of Medical Sciences' Institutional Ethics Committee offered an ethical clearance (approval no. AIMS/IEC/092/2024; dated 2 April 2024). All participants gave their informed consent in writing. There is no identifiable individual participant data in the manuscript.

DATA AVAILABILITY STATEMENT

The corresponding author may get the generated and analyzed datasets used in this study upon reasonable request, according to institutional and ethics committee requirements.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas. 11th ed. Brussels: International Diabetes Federation; 2025.
2. Anjana RM, Unnikrishnan R, Deepa M, Pradeepa R, Tandon N, Das AK, et al. Metabolic non-communicable disease health report of India: the ICMR-INDIAB national cross-sectional study. Lancet Diabetes Endocrinol. 2023;11(7):474-489. doi:10.1016/S2213-8587(23)00119-5.
3. Savelieff MG, Elafros MA, Viswanathan V, Jensen TS, Bennett DL, Feldman EL. The global and regional burden of diabetic peripheral neuropathy. Nat Rev Neurol. 2025;21(1):17-31. doi:10.1038/s41582-024-01041-y.
4. Feldman EL, Callaghan BC, Pop-Busui R, Zochodne DW, Wright DE, Bennett DL, et al. Diabetic neuropathy. Nat Rev Dis Primers. 2019;5(1):41. doi:10.1038/s41572-019-0092-1.
5. American Diabetes Association Professional Practice Committee for Diabetes. 12. Retinopathy, neuropathy, and foot care: Standards of Care in Diabetes-2026. Diabetes Care. 2026;49(Suppl 1):S261-S276. doi:10.2337/dc26-S012.
6. Selvarajah D, Kar D, Khunti K, Davies MJ, Scott AR, Walker J, et al. Diabetic peripheral neuropathy: advances in diagnosis and strategies for screening and early intervention. Lancet Diabetes Endocrinol. 2019;7(12):938-948. doi:10.1016/S2213-8587(19)30081-6.
7. Lavery LA, Armstrong DG, Vela SA, Quebedeaux TL, Fleischli JG. Practical criteria for screening patients at high risk for diabetic foot ulceration. Arch Intern Med. 1998;158(2):157-162. doi:10.1001/archinte.158.2.157.
8. Mathiyalagen P, Kanagasabapathy S, Kadar Z, Rajagopal A, Vasudevan K. Prevalence and determinants of peripheral neuropathy among adult type II diabetes mellitus patients attending a non-communicable disease clinic in rural South India. Cureus. 2021;13(6):e15493. doi:10.7759/cureus.15493.
9. Darivemula S, Nagoor K, Patan SK, Reddy NB, Deepthi CS, Chittooru CS. Prevalence and its associated determinants of diabetic peripheral neuropathy (DPN) in individuals having type-2 diabetes mellitus in rural South India. Indian J Community Med. 2019;44(2):88-91. doi:10.4103/ijcm.IJCM_207_18.

10. George H, Rakesh PS, Krishna M, Alex R, Abraham VJ, George K, et al. Foot care knowledge and practices and the prevalence of peripheral neuropathy among people with diabetes attending a secondary care rural hospital in southern India. J Family Med Prim Care. 2013;2(1):27-32. doi:10.4103/2249-4863.109938.
11. Lee CM, Chang CC, Pan MY, Chang CF, Chen MY. Insufficient early detection of peripheral neurovasculopathy and associated factors in rural diabetes residents of Taiwan: a cross-sectional study. BMC Endocr Disord. 2014;14:89. doi:10.1186/1472-6823-14-89.
12. Katulanda P, Ranasinghe P, Jayawardena R, Constantine GR, Sheriff MHR, Matthews DR. The prevalence, patterns and predictors of diabetic peripheral neuropathy in a developing country. Diabetol Metab Syndr. 2012;4:21. doi:10.1186/1758-5996-4-21.
13. Negussie YM, Bekele NT. Diabetic peripheral neuropathy among adult type 2 diabetes patients in Adama, Ethiopia: a health facility-based study. Sci Rep. 2024;14(1):3844. doi:10.1038/s41598-024-53951-y.
14. Feldman EL, Stevens MJ, Thomas PK, Brown MB, Canal N, Greene DA. A practical two-step quantitative clinical and electrophysiological assessment for the diagnosis and staging of diabetic neuropathy. Diabetes Care. 1994;17(11):1281-1289.
15. 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. Diabet Med. 2012;29(7):937-944. doi:10.1111/j.1464-5491.2012.03644.x.
16. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology statement: guidelines for reporting observational studies. PLoS Med. 2007;4(10):e296. doi:10.1371/journal.pmed.0040296.
17. American Diabetes Association Professional Practice Committee for Diabetes. 2. Diagnosis and classification of diabetes: Standards of Care in Diabetes-2026. Diabetes Care. 2026;49(Suppl 1):S27-S49. doi:10.2337/dc26-S002.
18. Schmitt A, Gahr A, Hermanns N, Kulzer B, Huber J, Haak T. The Diabetes Self-Management Questionnaire: development and evaluation of an instrument to assess diabetes self-care activities associated with glycaemic control. Health Qual Life Outcomes. 2013;11:138. doi:10.1186/1477-7525-11-138.
19. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. Med Care. 1986;24(1):67-74.