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ORIGINAL ARTICLE

Frequency of Neuropathy Symptoms in Diabetic Patients

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Abstract

Background/Aim: One of the most common consequences of diabetes mellitus is diabetic neuropathy, which is triggered on by nerve damage. The characteristic of neuropathies is a progressive loss of nerve fibre function resulting in numbness, tingling, aching, burning and throbbing sensations. In addition, it adds to the risk of falls, joint deformities, muscular atrophy and foot ulcers. The study aimed to analyse the incidence of motor and sensory dysfunctions in patients with diabetes mellitus in Chennai, India.
Methods: This was an observational study of analytic type. Clinically diagnosed diabetic patients between the age of 45 to 60 years were considered for this study. Patients who consented to participate in this study, with a history of diabetes mellitus spanning more than ten years were chosen. Patients found to have other causes of neuropathy, diabetic ulceration, lactating (or) pregnant women and non-cooperative patients were excluded from this study. All the subjects enrolled in the study at the mentioned centres were given the Michigan neuropathy screening instrument (MNSI). Total score of MNSI was calculated and interpreted for the prevalence.
Results: A total of 246 subjects have participated in this study out of which 54 % were male and 46 % were female, 127 (51 %) had diabetic peripheral neuropathy, 41 (17 %) had partial diabetic neuropathy and 78 (32 %) had no symptoms of diabetic neuropathy.
Conclusion: Through the questionnaire and physical examination, the current study demonstrated a high prevalence of motor and sensory impairments as well as diabetic neuropathy symptoms in the diabetic population.

Key words: Diabetes mellitus; Diabetic neuropathies; Michigan neuropathy screening instrument (MNSI); Peripheral nerve injury.

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Introduction

Diabetes mellitus, which is defined by persistently high blood sugar levels induced on by deficiencies in either insulin production, insulin action, or both, remains a major worldwide health concern. Globally, 415 million persons between the ages of 20 and 79 were predicted to have diabetes in 2019 by the International Diabetes Federation (IDF), with estimates that number will increase to 642 million by 2040.[1] This chronic condition not only affects glucose metabolism but also leads to a spectrum of microvascular and macrovascular complications.

Among the multitude complications associated with diabetes, diabetes-related peripheral neuropathy (DPN) constitutes severe complications of the disease. After ruling out other possible causes, DPN is defined as the existence of symp-

toms and/or indicators of peripheral nerve damage in people with diabetes.[2] It impacts between 30 % and 50 % of diabetic patients and is linked to a number of symptoms that have a major negative influence on the quality of life of the affected individuals.[3]

There are four different forms of diabetic peripheral neuropathy: symmetrical distal neuropathy, which is the most prevalent variety; symmetrical proximal neuropathy; asymmetric proximal neuropathy; asymmetric neuropathy and symmetric distal neuropathy.[4] Diabetic peripheral neuropathy symptoms vary widely from patient to patient. Diabetic peripheral neuropathy patients impose an enormous burden on the health-care system and report a low quality of life. Sensory, motor and autonomic nerve fibres may be involved in the clinical symptoms. Sensitivity to touch or temperature changes, tingling, burning, ache and numbness are common symptoms of sensory neuropathy.[5] Sensory symptoms particularly in the feet and legs not only cause discomfort but also elevate the chance of ulcers in the foot and injuries because of diminished sensation.[6] Motor neuropathy manifests as muscle weakness, loss of muscle mass and impaired coordination, particularly affecting the lower extremities which can lead to functional impairment and reduced mobility. The circulatory, gastrointestinal, genitourinary and sudomotor systems can break down in autonomic neuropathy, resulting in symptoms such orthostatic hypotension, gastroparesis, sexual dysfunction and decreased sweating.[7] The entire impact of these symptoms considerably degrades patients' quality of life, contributing to sleep problems, anxiety, sadness and decreased overall well-being.

The occurrence of diabetic peripheral neuropathy (DPN) is influenced by diabetes duration, age, glycaemic control and ethnicity, with higher incidence observed in African Americans and South Asians.[8] Among Asian Indians, the rise in diabetes is linked to better detection, Western dietary habits, sedentary lifestyles and urbanisation, with a significant urban-rural divide.[9] Prolonged hyperglycaemia leads to nerve damage through oxidative stress and advanced glycation end-products, making poor glycaemic control a key modifiable risk factor.[10] Type 2 diabetes is strongly associated with aging, long-term diabetes, sleep quality, smoking, hypertension and obesity.[11] Foot ulcers, affecting 15 % of diabetics, often lead to amputations, with diabetes being the leading cause of non-traumatic lower limb amputation worldwide.[12, 13]

It is imperative to identify diabetic peripheral neuropathy early in order to initiate prompt therapies and prevent irreparable nerve damage. Current guidelines recommend comprehensive clinical assessments, including sensory examinations, ankle reflex testing and monofilament testing to assess protective sensation.[14] The Michigan neuropathy screening instrument (MNSI) is a validated tool for assessing diabetic peripheral neuropathy, showing strong reliability and accuracy in clinical and research settings, making it widely used for diabetic populations.[15] Modern diagnostic techniques, like skin biopsies for intraepidermal nerve fibre density, nerve conduction analysis (NCS) and quantitative sensory tests (QST), help to confirm the diagnosis of DPN while also tracking the course of the condition and assessing the effectiveness of treatment plans.[16]

Healthcare professionals can apply tailored management strategies targeted at optimising patients' overall functional outcomes and improving symptom control when neuropathic symptoms are identified early. The study aimed to analyse the incidence, distribution patterns and clinical correlates of neuropathic symptoms in patients in Chennai, India with diabetes mellitus.

Methods

In this observational study, clinically diagnosed diabetic patients were assessed from an initial pool of 265 individuals, focusing on those aged 45 to 60 years who met the criteria of fasting blood sugar levels above 125 mg/dL and HbA_1c values higher than 6.5 %. The study took place at four clinics, including ACS Medical Campus in Chennai, with assessments conducted 2-3 times per week. Among the 265 patients, 19 (7.2 %) were excluded due to other causes of neuropathy. Other causes of neuropathy or ulceration included alcohol abuse, vitamin deficiencies (especially B_{12}), autoimmune diseases, infections (such as HIV or leprosy), chemotherapy and physical trauma.

Participants were given questionnaires in English and Tamil, divided into two sections. The first section collected sociodemographic information and details about their diabetes. Diabetic neuropathy was assessed in the second section using the MNSI. Both a physical examination and a history evaluation were part of the MNSI. The history questionnaire had 15 questions, with a "YES" response scoring 1 point for questions 1-15

Table 1: Questions in Michigan neuropathy screening instrument (MNSI) history questionnaire

Question	No /Yes
1. Are your legs and/or feet numb?	
2. Do you ever have any burning pain in your legs and/or feet?	
3. Are your feet too sensitive to touch?	
4. Do you get muscle cramps in your legs and/or feet?	
5. Do you ever have any prickling feelings in your legs or feet?	
6. Does it hurt when the bed covers touch your skin?	
7. When you get into the tub or shower, are you able to tell the hot water from the cold water?	
8. Have you ever had an open sore on your foot?	
9. Has your doctor ever told you that you have diabetic neuropathy?	
10. Do you feel weak all over most of the time?	
11. Are your symptoms worse at night?	
12. Do your legs hurt when you walk?	
13. Are you able to sense your feet when you walk?	
14. Is the skin on your feet so dry that it cracks open?	
15. Have you ever had an amputation?	

(except question 6, which was scored differently) (Table 1). The physical assessment involved evaluating patients while seated in a long sitting position for foot appearance, ulceration, ankle reflex, vibration sensation and light touch perception by 3 experienced physiotherapists.

With the foot slightly dorsiflexed, the ankle reflex was examined with a reflex hammer on the Achilles tendon as part of the physical examination. A 10-gram monofilament was used to evaluate light touch on the plantar side of the foot and a 128 Hz tuning fork was used to measure vibration feeling on the of the foot beneath the great toe.

Patients who scored ≥ 7/15 on the MNSI history questionnaire and ≥ 2.5/10 on the MNSI physical assessment were considered to have diabetic neuropathy. The degrees of polyneuropathy based on the MNSI questionnaire results were classified as follows: (1) No neuropathy for MNSI scores less than 2.5; (2) Level I (reversible changes) for MNSI scores between 2.5 and 7; and (3) Level II (irreversible changes) for MNSI scores greater than 7.[17] The study categorised all 246 patients based on their symptoms and examination into distinct stages of neuropathy. These stages included N0, indicating no neuropathy; N1a, where patients showed signs but no symptoms of neuropathy; N2a, characterised by symptomatic mild diabetic polyneuropathy with sensory, motor, or autonomic symptoms, yet the patients could heel-walk; N2b, which involved severe symptomatic diabetic polyneuropathy, with patients unable to heel-walk; and N3, denoting disabling diabetic polyneuropathy.[18]

Data were recorded in Microsoft Excel 2019 and organised for analysis. Descriptive analysis was performed and all parameters were assessed using SPSS version 28.

Results

A total of 246 subjects have participated in this study out of which 54 % were male and 46 % were female (Figure 1), with average age 54.4 ± 4.8 years and on average had diabetes mellitus for 13.2 ± 3.5 years (Table 2).

Responses of MNSI history questionnaire is presented in Figure 2, while results of physical examination on feet is presented in Figure 3 and 4. A staggering 76 % of the population exhibited changes in foot appearance, including dry skin, infections or fissures.

The study revealed significant neurological deficits among participants, with 26 % experiencing partial and 16 % complete loss of ankle reflexes, indicating peripheral nerve damage and early signs of peripheral neuropathy. Additionally, 16 % had reduced and 15 % complete loss of perception of 128 Hz vibration at the great toe, critical for balance and coordination. During the examination and history collection it was found that 52 % of patients had mixed neuropathy symptoms, 14 % had pure sensory neuropathy symptoms and only 2 % had motor neuropathy symptoms.

Table 2: Basic descriptive socio-demographic data of patients

Variables	Minimum	Maximum	Mean	SD	Skewness	
					Statistic	SE
Age	45.00	60.00	54.39	4.760	-0.495	0.155
Duration of diabetes	10.00	32.00	13.24	3.520	1.970	0.155
HbA_1C	6.00	8.00	6.76	0.614	0.615	0.155
BMI	16.90	30.20	23.50	3.460	-0.020	0.155

SD: standard deviation; SE: standard error, HbA1c: glycated haemoglobin; BMI: body mass index;

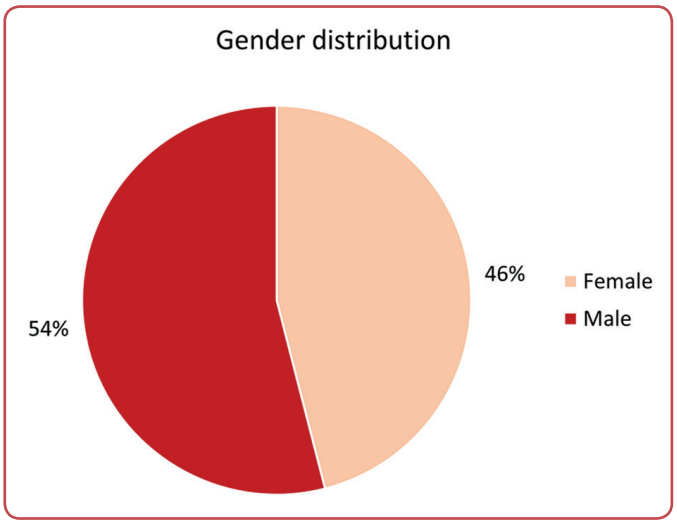

Figure 1: Gender distribution of diabetic patients

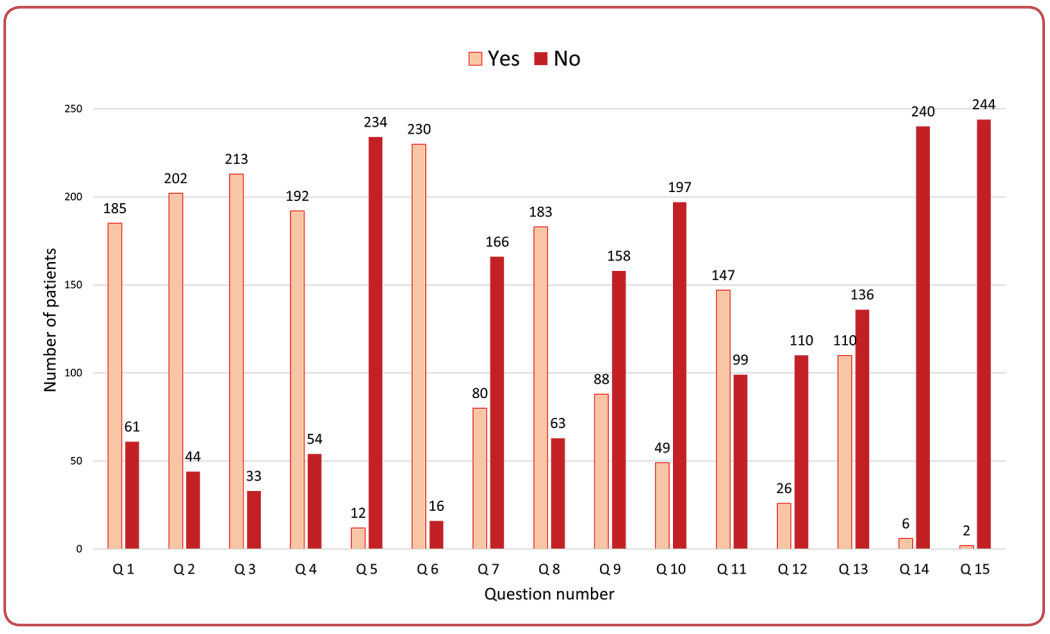

Figure 2: Michigan neuropathy screening instrument (MNSI) history questionnaire patient responses

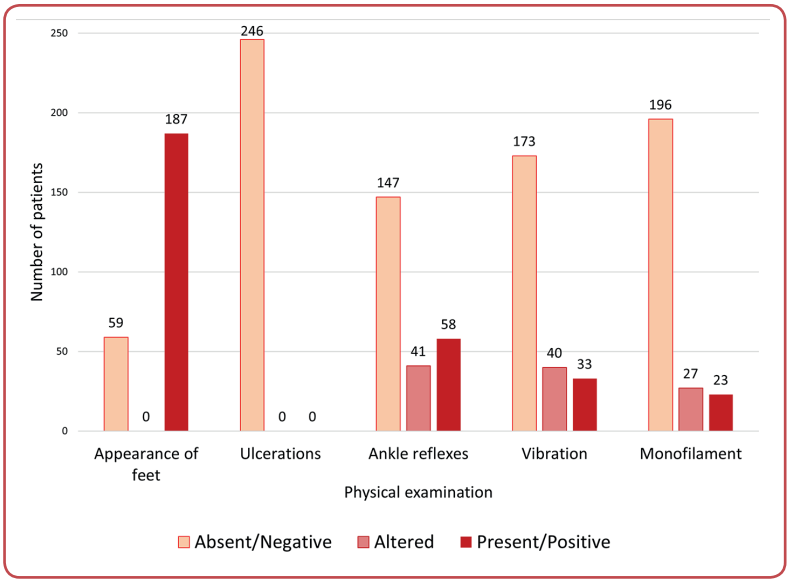

Figure 3: Michigan neuropathy screening instrument (MNSI) physical assessment score on right foot

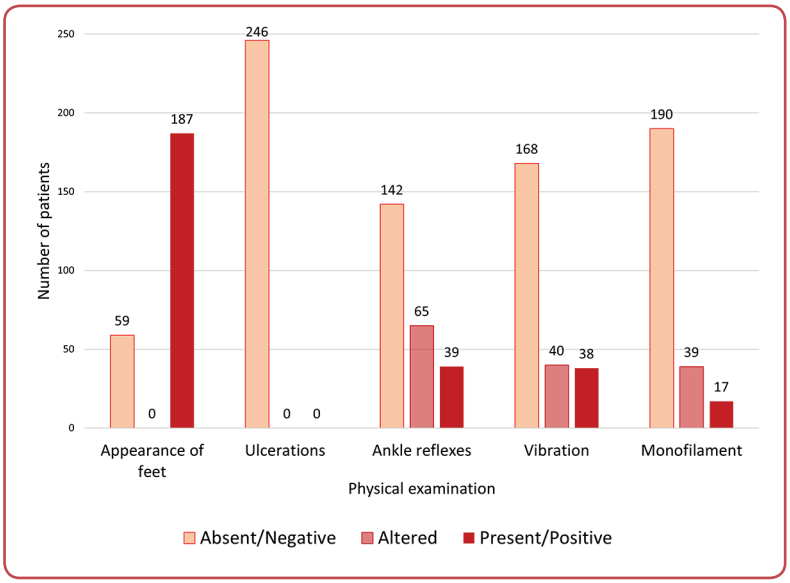

Figure 4: Michigan neuropathy screening instrument (MNSI) physical assessment score on left foot

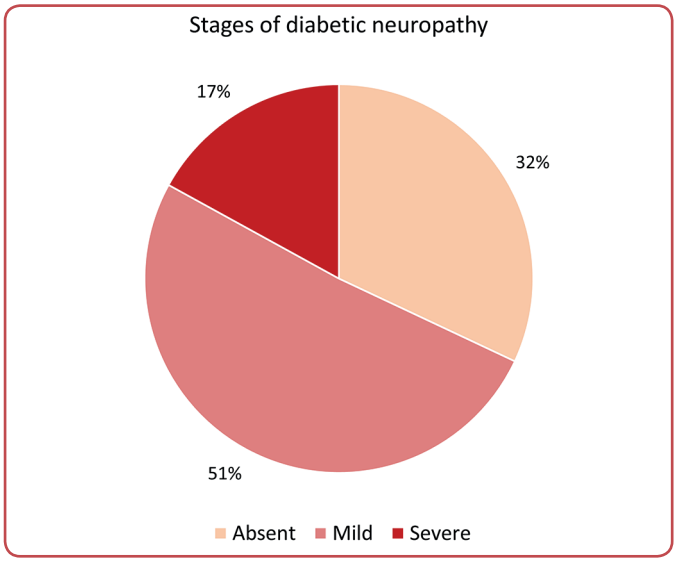

Figure 5: Neuropathy severity distribution in patients with diabetes mellitus

Out of total number of patients, 78 patients scored less than 2.5 on the MNSI, indicating no symptoms of diabetic neuropathy. In addition, 127 participants (51 %) were identified as mild diabetic neuropathy with MNSI scores between 2.5 and 7, while 41 participants (17 %) were identified as severe diabetic neuropathy with MNSI scores greater than 7 (Figure 5).

Discussion

Over 500 million individuals worldwide suffer from diabetes, a serious health issue with a remarkably high prevalence. Diabetic neuropathy, a chronic illness characterised by the slow loss of nerve fibres, affects both Type I and Type II diabetics. Diabetic neuropathy is closely associated with high morbidity and can drastically reduce the standard of living for patients and their relatives, resulting in both mental and physical health concerns. Individuals with diabetic neuropathy experience different symptoms. Initially, the illness damages tiny nerve fibres, resulting in pain and strange feelings like dysesthesia. As the disease advances and significant nerve fibres are affected, symptoms may include numbness, tingling, burning sensations, muscular weakness or atrophy, organ dysfunction and loss.

This study provides a comprehensive analysis of diabetic neuropathy among 246 diabetic patients a sample with a substantial prevalence of neuropathy, as indicated by the MNSI. Specifically, 51 % of the subjects exhibited mild and 17 % exhibited severe neuropathy, while 32 % had no neuropathy. These findings highlight the significant burden of diabetic neuropathy within this population.

The demographic distribution revealed that 54 % of the patients with diabetic neuropathy were male and 46 % were female. This gender distribution aligns with previous research demonstrating that the prevalence rates of diabetic neuropathy vary by gender. For example, Sujatha et al reported a similar distribution, though some studies indicate a higher prevalence in males, potentially due to differences in risk factors such as metabolic control or the duration of diabetes.[19]

During the examination and history collection it was found that 52 % of patients had mixed neuropathy symptoms, 14 % had pure sensory neuropathy symptoms and only 2 % had motor neuropathy symptoms. These outcomes coincide with those of Galiero et al who reported that sensory-motor axonal neuropathy is the most prevalent form among diabetic patients. The low incidence of motor neuropathy in this study is consistent with the progression pattern of diabetic neuropathy, where sensory neuropathy often precedes motor neuropathy.[20]

A staggering 76 % of the population exhibited changes in foot appearance, including dry skin, infections, or fissures. These alterations in foot health can be indicative of peripheral neuropathy or poor circulation. Peripheral neuropathy, commonly associated with diabetes, can lead to a loss of protective sensation, making individuals more susceptible to injuries and infections that may go unnoticed until they become severe. Poor circulation, often a result of vascular complications in diabetic patients, can exacerbate these issues by impairing wound healing and increasing the risk of infections.[21, 22] The high prevalence of foot appearance changes necessitates a proactive approach to foot care. Regular foot inspections, moisturising to prevent dry skin and prompt treatment of infections and fissures are essential components of comprehensive foot care.[23] Moreover, healthcare providers should emphasise the importance of wearing appropriate footwear to protect the feet from injuries and infections.[24]

The study revealed significant neurological deficits among participants, with 26 % experiencing partial and 16 % complete loss of ankle reflexes, indicating peripheral nerve damage and early signs of peripheral neuropathy.[25] This loss of reflexive response increases the risk of falls and injuries. Additionally, 16 % had reduced and 15 % complete loss of perception of 128 Hz vibration at the great toe, critical for balance and coordination, further elevating fall risk.[26]

Monofilament testing showed 15 % had reduced and 9 % complete loss of sensitivity to a 10-gram monofilament, highlighting a strong predictor of future foot ulcers, leading to severe complications, including amputation.[27] These findings highlight the critical need of educating patients about daily foot checks and proper hygiene, which can significantly lower the risk of severe complications. Healthcare providers should also stress the need for regular exercise, a balanced diet and routine health checks, encouraging patients to adhere to preventive measures for effective glycaemic con-

trol and the reduction of both sensory and motor deficits in diabetic patients. This study provides a comprehensive analysis of diabetic neuropathy patients, highlighting the symptoms and severity of the condition. It effectively examines gender distribution, symptom types and foot health, emphasising the need for proactive care. However, the study is limited by its sample size and lack of differentiating the types of diabetes. It focuses mainly on physical symptoms, with minimal exploration of psychological impacts or detailed risk factors. A more diverse sample and longitudinal studies would strengthen the findings.

Conclusion

In conclusion, this study reinforces the high prevalence and severe manifestations of diabetic neuropathy among diabetic patients. The findings emphasise the need for regular screening and proactive management to mitigate complications. In order to assess the efficacy of various therapeutic approaches and gain a deeper understanding of how neuropathy progresses, future research should focus on long-term studies with other advanced measuring tools.

Ethics

This study was approved by the institutional review board at the Faculty of Physiotherapy at Dr MGR Educational and Research Institute under the reference number E31/PHYSIO/IRB/2021-2022, dated 29 January 2022. Patients provided written informed consent before to participation in the trial and the publishing of anonymised data. Additionally, the questions were filled out anonymously. The procedure adhered to the guidelines set forth in the Helsinki Declaration of 1964, as revised in 2008.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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References

1. American Diabetes Association. Introduction: standards of medical care in diabetes-2022. Diabetes Care. 2022 Jan 1;45(Suppl 1):S1-S2. doi: 10.2337/dc22-Sint.
2. Callaghan BC, Cheng HT, Stables CL, Smith AL, Feldman EL. Diabetic neuropathy: clinical manifestations and current treatments. Lancet Neurol. 2012 Jun;11(6):521-34. doi: 10.1016/S1474-4422(12)70065-0.
3. Tesfaye S, Boulton AJ, Dyck PJ, Freeman R, Horowitz M, Kempler Pet al; Toronto Diabetic Neuropathy Expert Group. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. Diabetes Care. 2010 Oct;33(10):2285-93. doi: 10.2337/dc10-1303.
4. Dixit S, Maiya A. Diabetic peripheral neuropathy and its evaluation in a clinical scenario: A review. J Postgrad Med. 2014;60(1):33-40. doi: 10.4103/0022-3859.128805.
5. Sloan G, Selvarajah D, Tesfaye S. Pathogenesis, diagnosis and clinical management of diabetic sensorimotor peripheral neuropathy. Nature Rev Endocrinol. 2021 May 28;17. doi: 10.1038/s41574-021-00496-z.
6. Vinik AI, Erbas T. Diabetic autonomic neuropathy. Handb Clin Neurol. 2014;126:63-79. doi: 10.1016/B978-0-444-53491-0.00022-5.
7. Kanaya AM, Herrington D, Vittinghoff E, Ewing SK, Liu K, Blaha MJ, et al. Understanding the high prevalence of diabetes in U.S. south Asians compared with four racial/ethnic groups: the MASALA and MESA studies. Diabetes Care. 2014 Jun;37(6):1621-8. doi: 10.2337/dc13-2656.
8. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. Indian J Med Res. 2007 Mar;125(3):217-30. PMID: 17496352.
9. Boulton AJ, Vinik AI, Arezzo JC, Bril V, Feldman EL, Freeman R, et al; American Diabetes Association. Diabetic neuropathies: a statement by the American Diabetes Association. Diabetes Care. 2005 Apr;28(4):956-62. doi: 10.2337/diacare.28.4.956.
10. Ang L, Cowdin N, Mizokami-Stout K, Pop-Busui R. Update on the management of diabetic neuropathy. Diabetes Spectr. 2018 Aug;31(3):224-33. doi: 10.2337/ds18-0036.
11. Ismail L, Materwala H, Al Kaabi J. Association of risk factors with type 2 diabetes: A systematic review. Comput Struct Biotechnol J. 2021 Mar 10;19:1759-85. doi: 10.1016/j.csbj.2021.03.003.
12. Akkus G, Sert M. Diabetic foot ulcers: A devastating complication of diabetes mellitus continues non-stop in spite of new medical treatment modalities. World J Diabetes. 2022;13(12):1106–21. doi: 10.4239/wjd.v13.i12.1106.
13. MD Abu Bashar, Verma M. Prevalence and Determinants of Diabetic Peripheral Neuropathy/Foot Syndrome in the Rural population of North India. Iberoam J Med 2021;3(1):18-25. doi: 10.5281/zenodo.4393501.
14. American Diabetes Association Professional Practice Committee. 12. retinopathy, neuropathy, and foot care: standards of care in diabetes-2024. Diabetes Care. 2024 Jan 1;47(Suppl 1):S231-S243. doi: 10.2337/dc24-S012.
15. Pop-Busui R, Boulton AJ, Feldman EL, Bril V, Freeman R, Malik RA, et al. Diabetic neuropathy: a position statement by the American Diabetes Association. Diabetes Care. 2017 Jan;40(1):136-54. doi: 10.2337/dc16-2042.
16. Shillo P, Yiangou Y, Donatien P, Greig M, Selvarajah D, Wilkinson ID, et al. Nerve and vascular biomarkers in skin biopsies differentiate painful from painless peripheral neuropathy in type 2 diabetes. Front Pain Res (Lausanne). 2021 Oct 22;2:731658. doi: 10.3389/fpain.2021.731658.
17. Sher EK, Prnjavorac B, Farhat EK, Palić B, Ansar S, Sher F. Effect of diabetic neuropathy on reparative ability and immune response system. Mol Biotechnol. 2023 Jul 31. doi: 10.1007/s12033-023-00813-z.
18. Zochodne DW. Diabetes mellitus and the peripheral nervous system: manifestations and mechanisms. Muscle Nerve. 2007 Aug;36(2):144-66. doi: 10.1002/mus.20785.
19. Sujata, Thakur R. Unequal burden of equal risk factors of diabetes between different gender in India: a cross-sectional analysis. Sci Rep. 2021 Nov 22;11(1):22653. doi: 10.1038/s41598-021-02012-9.
20. Galiero R, Caturano A, Vetrano E, Beccia D, Brin C, Alfano M, et al. Peripheral neuropathy in diabetes mellitus: pathogenetic mechanisms and diagnostic options. Int J Mol Sci. 2023 Feb 10;24(4):3554. doi: 10.3390/ijms24043554.
21. Toma AI, Fuller JM, Willett NJ, Goudy SL. Oral wound healing models and emerging regenerative therapies. Translat Res. 2021 Oct;236:17–34. doi: 10.1016/j.trsl.2021.06.003.
22. Boulton AJM, Armstrong DG, Kirsner RS, Attinger CE, Lavery LA, Lipsky BA, et al. Diagnosis and management of diabetic foot complications. Arlington (VA): American Diabetes Association; 2018 Oct. doi: 10.2337/db20182-1.
23. Hingorani A, LaMuraglia GM, Henke P, Meissner MH, Loretz L, Zinszer KM, et al. The management of diabetic foot: A clinical practice guideline by the Society for Vascular Surgery in collaboration with the American Podiatric Medical Association and the Society for Vascular Medicine. J Vasc Surg. 2016 Feb;63(2 Suppl):3S-21S. doi: 10.1016/j.jvs.2015.10.003.
24. Krishnamoorthy S, Pandurangan V, Varadan S, Gopalan S, Singh S RB. Clinical characteristics and hospitalisation outcomes of hypoglycaemia in hospitalised patients with type 2 diabetes mellitus. Scr Med. 2024 May-Jun;55(3):287-96. doi: 10.5937/scriptamed55-50079.

25. Yang Z, Zhang Y, Chen R, Huang Y, Ji L, Sun F, et al. Simple tests to screen for diabetic peripheral neuropathy. Cochrane Database Syst Rev. 2018 Jul 30;2018(7):CD010975. doi: 10.1002/14651858.CD010975.pub2.
26. Ennion L, Hijmans J. Improving vibration perception in a patient with type 2 diabetes and sensory peripheral neuropathy. South African J Physiot. 2019 Jul 25;75(1). doi: 10.1016/j.trsl.2021.06.003.
27. Baraz S, Zarea K, Shahbazian H, Latifi S. Comparison of the accuracy of monofilament testing at various points of feet in peripheral diabetic neuropathy screening. J Diabetes Metabol Disor. 2014;13(1):19. doi: 10.1186/2251-6581-13-19.