ORIGINAL ARTICLE

Prevalence of Diabetic Peripheral Neuropathy among Type 2 Diabetes Mellitus patients and its associated risk factors

Kanchan Soni[1], Dhiraj Kumar Srivastava[2], Sandip Kumar[3], Prashant Kumar Bajpai[4], Sushil Kumar Shukla[5], Saurabh Prakash[6]

[1]Department of Community Medicine, Ganesh Shankar Vidyarthi Memorial Medical College, Kanpur, Uttar Pradesh;
[2,3,5]Department of Community Medicine, Uttar Pradesh University of Medical Sciences, Saifai, Etawah, Uttar Pradesh;
[4]Department of Community Medicine, King George's Medical University, Lucknow, Uttar Pradesh;
[6]Department of Radiation Oncology, Ganesh Shankar Vidyarthi Memorial Medical College, Kanpur, Uttar Pradesh

CORRESPONDING AUTHOR
Dr. Dhiraj Kumar Srivastava, Professor, Department of Community Medicine, Uttar Pradesh University of Medical Sciences, Saifai, Uttar Pradesh-206130
Email: dhirajk78sri@yahoo.co.in

CITATION
Soni K, Srivastava DK, Kumar S, Bajpai PK, Shukla SK, Prakash S. Prevalence of Diabetic Peripheral Neuropathy among Type 2 Diabetes Mellitus patients and its associated risk factors. Indian J Comm Health. 2024;36(2):208-214. https://doi.org/10.47203/IJCH.2024.v36i02.009

ARTICLE CYCLE
Received: 26/04/2023; Accepted: 15/03/2024; Published: 30/04/2024

ABSTRACT

Background: Diabetic peripheral neuropathy (DPN) is a common and one of the severe complications of diabetes mellitus. It affects almost half the diabetic population and worsens quality of life of the patient. The present study was aimed to determine the prevalence of peripheral neuropathy and associated risk factors. **Aims and Objectives**: To assess the Prevalence of Diabetic Peripheral Neuropathy (DPN) among Type 2 DM patients and its associated risk factors. **Material and Methods**: A community based survey was conducted over a period of one and a half year. Cluster sampling technique was used to collect the study sample in urban Etawah. Study participants aged ≥ 30 years residing in urban Etawah with known history of Type 2 Diabetes Mellitus of ≥ 5 years were included in the study. Diabetic Peripheral Neuropathy (DPN) was diagnosed using 10 g monofilament test. **Results**: A total of 400 DM patients were enrolled in the study. Out of which 28% (n = 112) patients were diagnosed with DPN using Semmes-Weinstein (SW) 10-g monofilament test. Statistically significant association was also noted with Family history of DM, BMI, Systolic and Diastolic blood pressure, Family history of HTN and History of Smoking. **Conclusion**: The current study found a high prevalence of DPN (28%) and it was found to be significantly associated with advancing age, duration of diabetes and history of smoking.

KEYWORDS
Diabetic Peripheral Neuropathy; Prevalence; Risk factors; Type 2 DM

INTRODUCTION

Diabetes mellitus (DM) is a major public health problem as depicted by rising prevalence worldwide. According to WHO, Diabetes can be defined as "A serious, chronic disease that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood glucose), or when the body cannot effectively use the insulin it produces."(1)

Type 1 diabetes is immune-mediated and requires daily administration of insulin and

Type 2 diabetes characterized by insulin resistance or relative insulin deficiency. Type 2 Diabetes Mellitus is the most common form of diabetes constituting 90 percent of the diabetic population. (2) The problem gets further worsened as the diagnosis of diabetes is often delayed for months to years due to lack of symptoms, lack of awareness and the fear of unknown in spite of awareness. Micro-vascular complications include Diabetic Peripheral Neuropathy (DPN), Retinopathy and Nephropathy. Diabetic neuropathy occurs in approximately 50% of individuals with long standing type 2 diabetes mellitus. The development of neuropathy correlates with duration of diabetes and glycemic control. Other risk factors are body mass index (BMI), (the greater the BMI, the greater the risk of neuropathy) and smoking. (3,4) The presence of cardiovascular disease and hypertension is also associated with diabetic neuropathy.

In Diabetic Peripheral Neuropathy (DPN), both myelinated and un-myelinated nerve fibres are lost. Peripheral neuropathy is assessed using Diabetic Neuropathy Symptom (DNS) score and Diabetic Neuropathy Examination (DNE). (4) Early identifications using various screening tools offer a crucial opportunity for the patient with type 2 diabetes mellitus to actively modulate the course of sub-optimal glycemic control and other associated factors before the onset of significant morbidity.(5,6)

The 2004 National Health and Nutrition Examination Survey (NHANES) have shown that nearly 30% of the diabetic patients have neuropathy. Signs & symptoms of neuropathy, indicates probable loss of protective sensation (LOPS).(7,8)

The early recognition and appropriate management of neuropathy in the patient with diabetes is important for a number of reasons:

- Diabetic neuropathy is a diagnosis of exclusion.
- A number of treatment options exist for symptomatic diabetic neuropathy.
- Up to 50% of DPN may be asymptomatic. If not recognized and if preventive foot care is not implemented, patients are at risk for injuries to their insensate feet.(9)

So the present study was conducted with the following objectives:

- To assess prevalence of Diabetic Peripheral Neuropathy (DPN) among Type 2 Diabetes Mellitus patients
- To assess risk factors in patients with Diabetic Peripheral Neuropathy

MATERIAL & METHODS

Study design: Community based survey

Study setting: Urban area of District Etawah

Study period: the present study was conducted for a period of one and a half year from January 2020- June 2021.

Sampling technique: Cluster sampling in urban area of District Etawah.

Study universe: Study participants aged ≥ 30 years residing in urban Etawah with known history of Type 2 Diabetes Mellitus of ≥ 5 years.

Exclusion criteria: 1. Participants who were severely ill and mentally challenged

Sample size: The sample was calculated by using the following formula:-

N = 4 PQ/L2 x design effect

Where P = Prevalence of diabetic peripheral neuropathy

Q = 100 – P

L is allowable error = 5 with design effect of 2.

Taking P = 13.2(10) and applying formula,

N= 2 x 4 x 13.2 x 86.8 / 5 x 5

= 366.64

= 367

Sample size derived was 367.

Final sample size taken for the study were 400.

Methodology: Cluster sampling technique was used for sample collection. First a list of all the wards of Urban Etawah was taken from the office of municipal corporation (Annexure I). There are 41 municipal wards. Out of this, 10 municipal wards were selected by using cluster sampling technique (10 x 40 clusters).

Steps of selection of wards-

1. First of all cumulative frequency of population was calculated.
2. Then divide the total population by the number of desired wards to get sampling interval.
3. Then we had chosen a number smaller than the number we got in above step using currency note method.
4. Then saw the obtained number in cumulative frequency table. The ward that

corresponds to that number was selected as ward number 1.
5. Then by adding step number (2) and (3), we got ward number 2.
6. Similarly add step (2) to the number we got till 10 wards were selected.

On reaching selected ward, a fixed structure was located which was of public importance like school, temples, etc. From this point, we move in the left-hand direction using house to house survey, till desired sample was reached. If the desired sample was not attained in selected ward, we moved to adjacent ward and repeat the process. If the household had >2 participant, the eldest one was selected. The eldest was selected because as the duration of the diabetes increases, prevalence of Diabetic Peripheral Neuropathy also increases. The selected participant was interviewed using pre-tested, pre-designed questionnaire, followed by Semmes Weinstein 10 g monofilament test and random blood sugar (RBS) was assessed by hand glucometer.

All the information were gathered using a semi structured, predesigned questionnaire. The questionnaire consists of two broad schedules:

1. Schedule I: Socio-demographic Profile
2. Schedule II: Anthropometric measurements and Neuropathy assessment

A) Anthropometric measurements: The Anthropometric measurements including weight, height (using stadiometer), body mass index(BMI; kg/m2) and waist circumference (using inelastic and flexible tape at the midpoint between the lower margin of the least palpable rib and top of the iliac crest nearest to 0.1 cm) were carried out at the time of recruitment. Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) levels of the participants were measured at the time of recruitment. Two readings were taken: one in the sitting position in the right arm to the nearest 2 mmHg with a mercury sphygmomanometer (Diamond Deluxe BP apparatus, BP Instruments, Pune, India), and the other in lying position and the average of the two reading was taken. The participants were considered to be hypertensive if were taking antihypertensive medication (as documented in clinic records) or SBP ≥140 mmHg or DBP ≥ 90 mmHg(JNC-8)

B) Assessment of Neuropathy: Neuropathy was assessed using 10-g monofilament pinprick sensations test and presence and absence of ankle reflexes. The 10-g Semmes Weinstein monofilament (SWMF's) was placed perpendicular to the skin and pressure was applied until the filament just buckled with a contact time of 2 s. Inability to perceive the sensation at any one site was considered abnormal. In addition, ankle reflexes were also assessed with a percussion hammer, and recorded as either present or absent. SWMF's were tested on the plantar surface of the hallux and central of the heel (when necessary after removal of excessive callus). This method was performed under standardized condition as per the accepted guidelines. The "yes-no" method was used. This means that the patient says "yes" each time that he or she senses the application of a monofilament.

Statistical Analysis: The data thus collected were entered in to Microsoft Excel Spreadsheet and were analysed using statistical software IBM SPSS (Statistical Package Social Science) version 24.0, IBM Inc. Chicago, USA software. Results were expressed in the form of tables and percentage and proportions. Chi square test was used for analysis and interpretation of data. All statistical significance was assessed at the 5% significance level. Categorical data were expressed as frequencies and percentages and continuous data as mean and standard deviation. Univariate and multivariate logistic regression were used for further analysis. A p-value of less than 0.05 was considered for statistical significance.

Ethical Consideration: Ethical clearance was obtained from the Ethical Clearance Committee of Uttar Pradesh University of Medical Sciences, Saifai, Etawah. Informed written consent was taken from all the subjects after explaining the purpose, nature and procedure of the study. No pressure or coercion was exerted on subjects for participation in the study. They were assured that confidentiality would be strictly maintained at all stages. The subjects were

free to leave the study at any time and no questions were asked.

RESULTS

The present study was conducted among 400 diabetic patients. In our study, prevalence of Diabetic Peripheral Neuropathy was found to be 28%(112/400). In the present study out of 400, 247 (61.7%) study subjects were males and 153(38.2%) study subjects were females. Majority of them were in the age group 50-59 years (40.5%) followed by 40-49 years. On applying univariate analysis to find out the association of DPN with various risk factors, statistically significant association was present with age of the participants. As the age advances, higher prevalence of DPN was noted. Similarly, statistically significant association was noted with the duration of diabetes, higher the duration of diabetes more was the prevalence of DPN. (Table 1)

Table 1: Association between diabetic peripheral neuropathy and certain risk factors of the study participants (n = 400)

SN	Risk Factor	DPN present(n=112)	DPN absent (n=288)	Total	P-value	Chi-square test
01	Age				<0.001	28.33
	<41	0	10	10		
	41-50	4	39	43		
	51-60	19	71	90		
	61-70	31	90	121		
	>70	58	78	136		
02	Gender					1.40
	Males	64	183	247	0.23	
	Females	48	105	153		
03	Duration of Diabetes mellitus (in years)				<0.001	25.36
	5-7	17	116	133		
	8-10	65	102	167		
	>10	30	70	100		
04	Family history of DM					
	Present	69	144	213	0.036	4.36
	Absent	43	144	187		
05	BMI (kg/m2)					
	<18.5	2	23	25	0.071	5.29
	18.5-23.9	31	75	106		
	≥ 24	79	190	269		
06	Systolic BP (mm Hg)					
	< 140	41	193	234	<0.001	30.01
	≥ 140	71	95	166		
07	Diastolic BP (mm Hg)					
	< 90	22	88	110	< 0.038	4.28
	≥ 90	90	200	290		
08	Family history of HTN					
	Present	101	205	353	< 0.001	15.15
	Absent	11	83	94		
09	History of smoking					
	Present	84	126	210	< 0.001	31.58
	Absent	28	162	190		
10	History of Alcohol consumption				0.166	1.91
	Present	62	137	199		
	Absent	50	151	201		

Statistically significant association was also noted with Family history of DM, BMI, Systolic and Diastolic blood pressure, Family history of HTN and History of Smoking (Table1)

However, no significant association was noted with the gender of participants and History of alcohol consumption (Table 1).

On application of multivariate analysis, among factors which have shown significant association in univariate analysis, it can be seen that significant association exist with the age of the participants, duration of DM and History of smoking (Table2)

On further application of multivariate analysis, age of the participants (between 51-60 years: OR = 1.89; p=0.034; >60 years: OR=1.67; p=0.041), duration of DM (between 8-10 years: OR = 1.26; p = 0.03) and history of smoking (OR = 0.64; p= 0.04) were identified as predictors for DPN.

Table 2: Strength of association of DPN with different parameters

SN	Risk Factor	OR	P-value	AOR	P-value
01	Age				
	<41	1			
	41-50	2.63(1.16-4.13)	0.0064	1.11(0.96-2.13)	0.089
	51-60	3.14(2.13-4.66)	0.0008	1.89(1.46-2.13)	0.034
	61-70	3.25(2.22-4.63)	0.0007	1.67(1.14-3.16)	0.041
	>70	4.11(2.89-5.11)	0.0001	2.11(1.92-4.11)	0.001
02	Duration of DM				
	5-7	1			
	8-10	2.14(1.16-3.73)	0.0003	1.26(1.11-3.14)	0.03
	>10	3.16(1.96-4.81)	0.0004	3.19(1.69-4.42)	0.001
03	Systolic BP				
	< 140	1			
	≥ 140	1.63(1.24-4.18)	0.003	0.96(0.73-2.16)	0.714
04	Diastolic BP				
	< 90	1			
	≥ 90	2.61(1.31-2.98)	0.0012	0.74(0.56-2.12)	0.82
05	Family history of HTN				
	Present				
	Absent	1			
		0.89(0.24-1.46)	1.26	0.13(0.11-1.13)	2.46
06	Family history of DM				
	Present				
	Absent	1			
		0.23(0.144-0.89)	0.0014	0.94(0.23-1.46)	0.84
07	History of smoking				
	Present				
	Absent	1			
		0.23(0.241-0.79)	0.0024	0.64(0.44-0.96)	0.04

DISCUSSION

The present study was conducted to assess the prevalence if Diabetic Peripheral Neuropathy(DPN) among patient with type 2 Diabetes mellitus. In this, 400 patients with Type 2 Diabetes mellitus were enrolled, out of which 112 (28%) showed sign & symptoms of DPN using Semmes-Weinstein (SW) 10-g monofilament test and presence and absence of ankle reflexes. Among 400 participants, 247 participants were male and 153 participants were female. The prevalence of DPN among male and female participants was 25.9% (64) and 31.5%(48) respectively and this difference was statistically not significant. Studies conducted by Sendi RA et al and other reported similar findings in their studies.(10-13)

In the present study, majority of the study participants were in the age group of >70 years followed by 61-70 years. On doing univariate analysis, it was found that as the age advance, prevalence of DPN also increases. Similarly, as the duration of Diabetes mellitus increases, the

prevalence of DPN also increases. This is in-line with the findings of Darivemula S et al and others(14-16).

It was observed in the present study that the prevalence of DPN was higher in participants who had a family history of Diabetes mellitus. This could be due to the fact that the persons with family history of Diabetes mellitus could have early onset of Diabetes mellitus and have longer duration of Diabetes mellitus which predisposes to him/her to DPN. This is similar to the findings of other researcher.(10,11,14)

On doing univariate analysis, statistically significant association was noted with systolic Blood pressure, Diastolic Blood pressure and family history of blood pressure. The probable cause of this association could be common non modifiable risk factors between the two variables. Studies conducted by Gogia S et al(15) in Karnataka, Janghorbani M et al (17) in Iran and Jarmuzewska EA(18) et al also noted similar findings.

It was also noted in the present study that statistically significant association also exist between history of smoking and presence of DPN. In the present study nearly 40% of the participants gave the history of smoking. Similar findings was also reported by Gogia S et al(15), Mold JW et al(19) and Mitchell BD et al.(20) The association between smoking and DPN can be explained with the fact that smoking itself is an independent risk factor for DPN and with the addition of Diabetes mellitus, the combination become appears to be synergistic. It was observed that those participants with the history of smoking for more than 5 years and with advance age are more likely to develop DPN. Mitchell BD et al(20) noted that both the current and ex-smokers were more likely to develop Neuropathy compared to those who have never smoked.

It was found that in the present study no statistically significant association exist between DPN and Body Mass index (BMI) or history of alcohol consumption. Studies conducted by Booya et al(21) and Tammer et al(22) noted significant association between DPN and alcohol consumption. The lack of association could be due to limited sample size. So, a larger study with bigger sample size is required to make comment on this association.

On further application of multivariate analysis of variables which showed statistically significant association on univariate analysis, it was noted that a statistically significant association exist between age of participant, duration of Diabetes mellitus and history of smoking. It was noted that as the age advance the prevalence of DPN increases (41-50 years: OR=1.1 vs >70 years OR=2.11). The DPN is more prevalent in the advance age and in participants with longer duration of Diabetes mellitus (8-10 years: OR=1.26 vs >10 years: OR=3.19). Persons with advance age and longer duration could have damage of small blood vessels which nourishes the nerves with oxygen and nutrients.

The multivariate analysis also noted statistically similar association between smoking and DPN. The reasons of this association is explained above.

CONCLUSION

The present study concludes that the DPN is quite prevalent among patients of Diabetes mellitus. The prevalence increases as the age advance and the duration of Diabetes mellitus increases. So, the early screening of DPN using simple ad cost effective tools like Semmes-Weinstein (SW) 10-g monofilament test could help in early identification of the disease and thus reduce its complications.

The patients of Diabetes mellitus should be motivated to quit smoking and alcohol consumption to reduce the risk of DPN.

Persons with advance age and longer duration should be regularly screened for the sign and symptoms of DPN as they are at more risk of developing DPN.

LIMITATIONS OF STUDY

The current study has some limitation. Nerve conduction studies (NCS) which is the gold standard test to diagnose DPN could not be performed due to financial constraints; as well as aetiology determination of DPN (e.g., vitamin B12 or folic acid deficiency) further confines the effectiveness of the present study's outcome. Also, the study didn't account for other potential confounders such

as musculoskeletal conditions of the old age, nutritional deficiencies etc. which might mimic the symptoms of DPN. The strength of this study is the use of simple, non-invasive, economical and quick methods to evaluate DPN. The ease to perform these bedside tests in a busy clinical setting and its availability at a low cost make them good screening tests.

AUTHORS CONTRIBUTION

All authors have contributed equally.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil

CONFLICT OF INTEREST

There are no conflicts of interest.

DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors haven't used any generative AI/AI assisted technologies in the writing process.

REFERENCES

1. Marathe PH, Gao HX, Close KL. American Diabetes Association Standards of Medical Care in Diabetes 2017. Journal of diabetes. 2017;9(4):320-4.
2. Vinik AI. Diabetic neuropathies. In Controversies in Treating Diabetes 2008:135-156. Humana Pres
3. Tesfaye S, Chaturvedi N, Eaton SE, Ward JD, Manes C, Ionescu-Tirgoviste C, Witte DR, Fuller JH. Vascular risk factors and diabetic neuropathy. New England Journal of Medicine. 2005;352(4):341-50.
4. Cameron NE, Eaton SE, Cotter MA, Tesfaye S. Vascular factors and metabolic interactions in the pathogenesis of diabetic neuropathy. Diabetologia. 2001;44(11):1973-88.
5. Duby JJ, Campbell RK, Setter SM, White JR, Rasmussen KA. Diabetic neuropathy: an intensive review. American Journal of Health-System Pharmacy. 2004;61(2):160-73.
6. Vinik AI, Mehrabyan A. Diabetic neuropathies. The Medical clinics of North America. 2004;88(4):947-9.
7. Singh R, Kishore L, Kaur N. Diabetic peripheral neuropathy: current perspective and future directions. Pharmacological research. 2014;80:21-35.8.
8. Tesfaye S, Boulton AJ, Dyck PJ, Freeman R, Horowitz M, Kempler P, Lauria G, Malik RA, Spallone V, Vinik A, Bernardi L. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. Diabetes care. 2010;33(10):2285-93.
9. DCCT Research Group. Factors in development of diabetic neuropathy: baseline analysis of neuropathy in feasibility phase of Diabetes Control and Complications Trial (DCCT). Diabetes. 1988;37(4):476-81.
10. Kisozi T, Mutebi E, Kisekka M, Lhatoo S, Sajatovic M, Kaddumukasa M, Nakwagala FN, Katabira E. Prevalence, severity and factors associated with peripheral neuropathy among newly diagnosed diabetic patients attending Mulago hospital: a cross-sectional study. Afr Health Sci. 2017;17(2):463-473.
11. Sendi RA, Mahrus AM, Saeed RM, Mohammed MA, Al-Dubai SAR. Diabetic peripheral neuropathy among Saudi diabetic patients: A multicenter cross-sectional study at primary health care setting. J Family Med Prim Care. 2020;9(1):197-201.
12. 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.
13. Jasmine, A., G.V., A., Durai, V. et al. Prevalence of peripheral neuropathy among type 2 diabetes mellitus patients in a rural health centre in South India. Int J Diabetes Dev Ctries 2021;41: 293–300.
14. 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.
15. Gogia S, Rao CR. Prevalence and Risk Factors for Peripheral Neuropathy among Type 2 Diabetes Mellitus Patients at a Tertiary Care Hospital in Coastal Karnataka. Indian J Endocrinol Metab. 2017;21(5):665-669.
16. Davies M, Brophy S, Williams R, Taylor A. The prevalence, severity, and impact of painful diabetic peripheral neuropathy in type 2 diabetes. Diabetes Care 2006;29:1518-22. [PubMed] [Google Scholar]
17. Janghorbani M, Rezvanian H, Kachooei A, et al. Peripheral neuropathy in type 2 diabetes mellitus in Isfahan, Iran: prevalence and risk factors. Acta Neurol Scand 2006;114:84-91.
18. Jarmuzewska EA, Ghidoni A, Mangoni AA. Hypertension and sensorimotor peripheral neuropathy in type 2 diabetes. Eur Neurol. 2007;57(2):91-5.
19. Mold JW, Vesely SK, Keyl BA, et al. The prevalence, predictors and consequences of peripheral sensory neuropathy in older patients. J Am Board Fam Pract 2004;17:309-18.
20. Braxton D Mitchell, Victor M Hawthorne, Aaron I Vinik; Cigarette Smoking and Neuropathy in Diabetic Patients. Diabetes Care 1 April 1990; 13 (4): 434–437
21. Booya F, Bandarian F, Larijani B, Pajouhi M, Nooraei M, Lotfi J. Potential risk factors for diabetic neuropathy: a case control study. BMC Neurol. 2005 Dec 10;5:24
22. Tamer A, Yildiz N, Kanat M, Gunduz H, Tahtaci M, CelebiH: The prevalence of neuropathy and relationship with riskfactors in diabetic patient : a single-centre experience. Med Princ Pract. 2006;15:190–194