

Prevalence of diabetic peripheral neuropathy using Michigan Neuropathy Screening Instrument (MNSI) in an urban population in India

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Background: Diabetes mellitus (D.M.) is a significant public health problem worldwide. Diabetic peripheral neuropathy (DPN) is a microvascular complication of type 2 diabetes mellitus attributed to chronic hyperglycemia. It is defined as symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after excluding other causes. Study was conducted to estimate Prevalence of diabetic peripheral neuropathy among type 2 diabetic patients in an urban population. **Methods:** This study was conducted among patients attending Urban Health Centres, Belagavi in Karnataka, over four months. A total of 250 patients with more than six months of type 2 diabetes mellitus were screened using a questionnaire version of Michigan Neuropathy Screening Instrument (MNSI). **Results:** Overall Prevalence of DPN among study participants based on MNSI was 35.2%. Based on MNSI assessment, 21.6% and 29.2% of participants scored ≥ 7 in history section of questionnaire and ≥ 2.5 in physical examination section, respectively. Prevalence of DPN was significantly higher among those with age more than 50 yrs and those with a history of either tobacco or alcohol consumption. Prevalence of DPN was also higher among patients with HBA1c $\geq 7\%$ and those with a duration of D.M. >10 years. **Conclusions:** Use of MNSI as a screening tool in primary health care setting could be a cost-effective means for early detection of DPN and to prevent diabetic foot ulcerations and infections.

Keywords: Diabetic peripheral neuropathy, Michigan neuropathy screening instrument, Type 2 diabetes mellitus, Prevalence

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Introduction

Diabetes mellitus (D.M.) is a significant public health problem worldwide. According to the International Diabetes Federation, approximately **425 million adults** (20-79 years) live with diabetes; by 2045, this will rise to **629 million**. With a national D.M. prevalence of 10.4%, India is home to the second-largest number of adults living with diabetes worldwide, after China. [1]. Diabetic peripheral neuropathy (DPN) is a microvascular complication of type 2 diabetes mellitus (T2DM) attributed to chronic hyperglycemia. It is defined as symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after excluding other causes [2]. Patients with DPN develop an inability to perceive significant sensations (heat, cold and pain) in extremities. As a result of lack of these sensations, there is an increased risk of foot infections, ulcers and non-traumatic amputations. The Prevalence of foot infections in T2DM patients ranges from a lifetime risk of 4-7% annually [3]. Patients with diabetes are challenging to treat once they develop neuropathy. Studies have shown that DPN generates significant reductions in the patient's quality of life and a substantial burden on the health expenditures globally [4-6]. Hence, the problem of DPN demands frequent screening. American Diabetes Association (ADA) recommended at least annual screening of all individuals with Diabetes for DPN [7]. Screening for DPN with a simple objective tool is essential, as the early detection of DPN could minimize the damaging effects of this serious but manageable microvascular complication and, in turn, improve the quality of life of such patients [8].

The study was conducted with the objectives to estimate the Prevalence of DPN and also to identify the determinants of DPN among T2DM using a rapid screening tool.

Material and Methods

Study population: The present study was conducted among type 2 diabetes mellitus patients attending Ashok Nagar Urban Health Centre [UHC] and Rukmini Nagar Urban Health Centre in Belagavi, Karnataka.

Study design: Cross-sectional study

Study period: August 2017 to November 2017

Sample size: Sample size was calculated

As 250, assuming that the Prevalence of diabetic peripheral neuropathy among South Indian diabetic patients is 19.1% [9] and that the true Prevalence is expected to fall within $\pm 5\%$ with a confidence level of 95%, using the formula $n = 4pq / d^2$

Sampling method: Convenient sampling method

Selection Criteria:

- **Inclusion criteria** - Patients with type 2 diabetes mellitus of at least six months duration who attended OPD at UHC Ashok Nagar and Rukmini Nagar [10].
- **Exclusion criteria** - Type 1 diabetes mellitus patients, lower extremity amputations, auto-immune diseases, severe osteoarthritis in lower extremity joints, congenital neuropathy

Study tool: Socio-demographic profile of the study patients was collected using a predesigned and pretested questionnaire. Screening for DPN was done using Michigan Neuropathy Screening Instrument (MNSI). MNSI is designed to screen for diabetic neuropathy in an outpatient setting by primary health care providers. The first part of the screening instrument consisted of 15 self-administered "yes or no" questions on foot sensation, including pain, numbness and temperature sensitivity. The second part of the MNSI was a brief physical examination involving 1) inspection of the feet for deformities, dry skin, hair or nail abnormalities, callus or infection, 2) semi-quantitative assessment of vibration sensation at the dorsum of the great toe, 3) grading of ankle reflexes and 4) monofilament testing [11].

Scoring the 'history' section of Michigan Neuropathy Screening Instrument: The first part of the MNSI questionnaire asked the participants about the presence or absence of symptoms related to DPN. Responses were added to obtain the total score. Responses of yes to items 1-3, 5-6, 8-9, 11-12, 14-15 were counted as one point. A no response on items 7 and 13 were counted as 1 point each. Item number 4 was a measure of impaired circulation, and item number 10, a measure of general asthenia, was not included in the scoring. A score of ≥ 7 was taken as positive for the DPN [12].

Scoring of 'examination' section of Michigan Neuropathy Screening Instrument: After examining the patient's extremities, each item was given a score of 0 if no finding was present

And a score of 1 if any abnormality was detected. After summing up all the components, if the overall score was ≥ 2.5 , it was considered positive for the presence of DPN [11].

Data analysis: The information collected was entered and analyzed using SPSS version 20. The data were analyzed in terms of descriptive statistics and bivariate analysis (Chi-square test). We undertook both unadjusted and adjusted logistic regression analysis to assess the association between socio-demographic variables (age, sex, marital status, literacy, smoking, alcoholic status), clinical variables (duration of illness) and Prevalence of DPN. The variables (viz. gender, smoking status, alcohol consumption and age groups), which were significant on bivariate analysis, were subjected to logistic regression. $P < 0.05$ was considered evidence of a statistically significant difference between predictive and outcome variables. Odds ratios (O.R.s) and corresponding 95% confidence intervals (C.I.s) were estimated.

Results

Table 1 shows the socio-demographic characteristics of the study participants. Out of 250 study participants, 64.8% were in the age group of 51 - 70 years, forming the majority of the participants. The average age of the study participants was 60.54 ± 9.44 (mean \pm S.D.), with a range of 32 to 79 years of age. 53.2% were females, and 46.8% were males. 33.2% of the participants did not have any kind of formal education. Over one-third of the study, participants belonged to socioeconomic status (SES) class III (33.2%). The mean duration of diabetes mellitus in the study population was found to be 9.37 ± 4.76 years (range, 5-30 years). The Prevalence of tobacco consumption and alcohol consumption was 26.8% and 24.8%, respectively. The Prevalence of overweight and obesity among the study participants was 17.6% and 58.8%, respectively. The Prevalence of hypertension among the study participants was 65.6%. (Table 2)

Prevalence of DPN based on Michigan Neuropathy Screening Instrument

The overall Prevalence of DPN among study participants based on MNSI was 35.2% (88). Based on the MNSI assessment, 21.6% and 29.2% of study participants had a score of ≥ 7 in the history section of the MNSI and a score of ≥ 2.5 in the physical examination section, respectively.

Table 1. Distribution of study participants according to socio-demographic characteristics (n = 250)

Parameters	Number s	Percentage (%)
Age (years)		
32-50	54	21.6
51-70	162	64.8
71-79	34	13.6
Sex		
Male	117	46.8
Female	133	53.2
Education		
Literates	167	66.8
No Formal education	83	33.2
Marital Status Single/divorced and widowed		
Married	40 210	16 84
Socio-economic status		
Class I	33	13.2
Class II	35	14.0
Class III	83	33.2
Class IV	72	28.8
Class V	27	10.8

Table 2. Distribution of study participants according to clinical, biochemical and other characteristics (n = 250)

Duration since diagnosis of diabetes mellitus		
Less than 10 yrs	172	68.8
More than 10 yrs	78	31.2
Smoking		
Yes	67	26.8
No	183	73.2
Alcohol		
Yes	62	24.8
No	188	75.2
BMI		
Underweight	5	2
Normal	54	21.6
Overweight	44	17.6
Obese	147	58.8
Hypertension		
Yes	164	65.6
No	86	34.4
HbA1c		
Controlled $< 7\%$	77	30.8
Uncontrolled $\geq 7\%$	173	69.2

The history section of the MNSI revealed that the most frequently reported symptoms in DPN patients

Were prickling feelings in legs or feet (73.86%) followed by legs hurt while walking (62.5%), burning pain in legs and feet (61.36%) and numbness of legs and feet (60.23%). The least reported conditions were a history of one or more toes amputation and the inability to differentiate hot water from cold water. Only 6.82% of them reported that they were already told that they had DPN by their treating physician. (Table 3) The Prevalence of DPN was significantly higher among those with age more than 50 yrs and those with a history of tobacco or alcohol consumption. The Prevalence of DPN was also found to be higher among patients with HBA1c \geq 7% and those with a history of D.M. for >10 years (Table 4, 5). On multivariate logistic regression analysis, DPN was found to be significantly associated with age more than 50 years [OR: 1.628 (1.006 - 2.635)]. The corresponding odds ratios and confidence intervals have been mentioned in detail in Table 6.

Table 3: Responses to Michigan neuropathy screening instrument questionnaire among patients with diabetic peripheral neuropathy (n = 88)

A: Symptom	Number	Percentage (%)
Numbness of legs and/or feet	53	60.23
Burning pain in legs and/or feet	54	61.36
Feet too sensitive to touch	37	42.04
Prickling feelings in legs or feet	65	73.86
Feeling of hurt when the bed covers touch skin	15	17.04
Ability to tell the hot water from the cold water?	6	6.82
Ever had an open sore on the foot	22	25
Doctor ever told you that you have diabetic neuropathy?	6	6.82
Symptoms worse at night	40	45.45
Legs hurt while walking	55	62.5
Ability to sense your feet while walking	8	9.09
Is the skin on your feet so dry that it cracks open?	19	21.59
Ever had an amputation	0	0
B: Physical examination	Right foot: N (%) Left foot: N (%)	
Abnormal appearance of feet	77(87.5)	73(82.95)
Ulceration	6(6.81)	5(5.68)
Ankle reflexes abnormality	11(12.5)	16(18.18)
Vibration perception abnormality	13 (14.77)	13 (14.77)
Monofilament test abnormality	58(65.91)	57(64.77)

Table 4. Socio-demographic profile of the study participants associated with diabetic peripheral neuropathy (bivariate analysis).

Variables	Number	DPN	No DPN	p-value
Age group (years)				
<51 years	54	13(24.07)	41(75.93)	
51 - 70 years	162	57(35.19)	105(64.81)	0.0
>70 years	34	18(52.94)	16(47.06)	22*
Gender				
Male	117	42(35.90)	75(64.10)	
Female	133	46(34.59)	87(65.41)	0.829
Education				
Literate	167	57(34.13)	110(65.87)	
Illiterate	83	31(37.35)	52(62.65)	0.616
Marital Status				
Single/divorced and widowed	40	16(40)	24(60)	
Married	210	72(34.29)	138(65.14)	0.488
Socioeconomic status				
Class I	33	17(51.52)	16(48.48)	
Class II	35	11(31.43)	24(68.57)	0.2
Class III	83	29(34.94)	54(65.06)	67
Class IV	27	24(33.33)	3(11.11)	
Class V	7	7(25.93)	0(0)	

*Shows statistical significance

Table 5. Risk factors of the study participants associated with diabetic peripheral neuropathy (bivariate analysis).

Variables	Number	DPN	No DPN	p-value
Duration of DM				
Less than 10 yrs	172	53(30.81)	119(69.19)	
More than 10 yrs	78	35(44.87)	43(55.13)	0.031*
Tobacco consumption				
Yes	67	31(46.27)	36(53.73)	
No	183	57(31.15)	126(68.85)	0.027*
Alcohol consumption				
Yes	62	29(46.77)	33(53.23)	
No	188	59(31.38)	129(68.62)	0.028*
BMI				
Underweight	5	1(20)	4(80)	
Normal	54	14(25.93)	40(74.07)	
Overweight	44	20(45.45)	24(54.55)	0.2
Obesity	147	53(36.05)	94(63.95)	0.02
Hypertension				
Yes	164	58 (35.37)	106(64.63)	
No	86	30 (34.88)	56 (65.12)	0.940
HBA1c				
Controlled <7%	77	20(28.57)	57(70.13)	
Uncontrolled \geq 7%	173	68(37.57)	105(62.43)	0.042*

*Shows statistical significance

Table 6: Unadjusted and adjusted odds ratios (O.R.s) for determinants associated with diabetic peripheral neuropathy (Multivariate analysis)

Determinants	Unadjusted Ors		Adjusted Ors	
	OR (CI)	p – value	OR (CI)	p – value
Age > 50 yrs	1.875 (1.182 – 2.975)	0.008*	1.628 (1.006 – 2.635)	0.047*
Duration of Diabetes > 10 yrs	1.828 (1.053 – 3.172)	0.032*	1.553 (0.862 – 2.797)	0.142
Tobacco consumption	1.904 (1.073 – 3.377)	0.028*	1.544 (0.768 – 3.101)	0.222
Alcohol consumption	1.921 (1.069 – 3.453)	0.029*	1.452 (0.713 – 2.958)	0.304
HBA1c uncontrolled ≥7%	1.846 (1.019 – 3.342)	0.043*	1.735 (0.937 – 3.214)	0.08

*Shows statistical significance

Discussion

The present study was conducted to assess the Prevalence of DPN among T2DM patients attending UHCs. The distribution of the study participants was such that most of them were between the age group 51 and 70 years which shows that T2DM was more prevalent among this age group. This observation conforms with the WHO report, which predicts that in India and other developing countries, the highest increase would occur in the age group of 45-65 years [13]. In our study, the overall Prevalence of DPN based on MNSI was 35.2%. Our findings are consistent with the studies conducted in Iran, Spain and Saudi Arabia, which reported the Prevalence of DPN as 31.9%, 24.1%, 45%, respectively [14-16]. Higher Prevalence than our study was noted in the studies conducted by Boru et al. in turkey and Al Sarihin et al. in Jordan, which reported the Prevalence of DPN as 60% and 54.4%, respectively [17-18]. The Prevalence of peripheral neuropathy varied from 19.2 to 47% in various studies done in India. [9, 10, 19]. The variations in the Prevalence of DPN across the studies can be due to the differences in study designs, type of study population included and different types of scales/instruments used to assess the magnitude of DPN in different study settings. In our study, the Prevalence of DPN based on the MNSI questionnaire section was 21.6% and based on the physical examination section was 29.2%.

Similar findings were noted in the studies conducted by D'Souza et al. and Khawaja et al. [8, 20]. The difference in prevalence rates using two methods clearly shows the limitations related to self-perception of symptoms of DPN by the patients. Furthermore, it brings out the importance of using screening techniques that involve examination of the patients in screening for DPN. The high Prevalence of DPN in our study and the low percentage (6.82%) of participants who were already told that they had DPN by their treating physicians indicates the gap between the onset of DPN and diagnosis among the patients. This highlights the need for early screening and proper foot care among people with diabetes. In multivariate logistic regression, we observed that age >50 years (OR – 1.628, CI: 1.006 - 2.635) was significantly associated with DPN. Similar findings were observed in other studies [8, 14, 18, 21-23]. Gender-specific predispositions to DPN has been observed in some studies, with males developing DPN earlier than females with the explanation of men's lifestyles being more hazardous than women's [8,24,25]. However, the present study showed no difference in the DPN rate between the genders, which others have also reported [9, 14,26,27].

In our study, although bivariate analysis showed that DPN was significantly associated with the longer duration of T2DM, it was not significant in multivariate analysis. This signifies the need for early screening for DPN, regardless of the duration of the T2DM, considering the likelihood of late diagnosis. The study was conducted among the patients attending the UHCs, covering only that part of the type 2 diabetes mellitus population. Hence, the conclusions from this cannot be generalized to the general population. The use of rapid, sensitive, validated, and inexpensive screening tools as MNSI to determine the community prevalence of DPN will improve the validity of the current study results. But, MNSI will assess only large-fibre neuropathy but not adequately assess small-fibre neuropathy, which is an important component of DPN. Hence, electrophysiological studies are needed for the final diagnosis. Lack of a definite tool for diagnosing neuropathy and lack of causality determination of DPN like vitamin B12 or folic acid deficiency further confines the effectiveness of the present study's results.

Conclusion

Peripheral neuropathy is the most common complication of diabetes mellitus, which, if set in, has a severe impact on the patient's quality of life. Our study concluded that the Prevalence of the DPN using MNSI was 35.2%. Advancing age, longer duration of diabetes, smoking, alcohol consumption and individuals with uncontrolled diabetes were associated with a higher proportion of peripheral neuropathy. Only advancing age was found to be significantly related to peripheral neuropathy in the multivariate analysis. Routine screening and regular follow up examinations would go a long way in early detection, reducing the burden of disability among people with diabetes and improving their quality of life significantly. MNSI as a screening tool in the primary health care setting is a cost-effective means for early detection of DPN and to prevent diabetic foot ulcerations and infections.

What the Study Adds To Existing Knowledge

Our study covered type 2 diabetes mellitus patients attending urban health centres who approached the centres for follow up and management of their condition. So our results may apply to patients receiving care in the community. The use of valid, easy to use and inexpensive screening tools as MNSI to determine the Prevalence of DPN will enhance the validity of the current study results.

Author's contribution

Dr Jambulingam Vasanthakumar: Concept, design, literature review, data collection, analysis, manuscript preparation & editing. **Dr Babu Suwethaa:** Data analysis, manuscript preparation & final editing. **Dr Bhuvana Gajula:** Data collection, Data tabulation & reference writing. **Dr Aniket Manoli:** Literature review, Data collection.

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