Original Article

Prevalence and Its Associated Determinants of Diabetic Peripheral Neuropathy (DPN) in Individuals Having Type-2 Diabetes Mellitus in Rural South India

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Abstract

Background: Diabetic peripheral neuropathy (DPN) is a well-known microvascular complication of type 2 diabetes mellitus attributed to chronic hyperglycemia and is defined as the presence of peripheral nerve dysfunction after exclusion of other causes. **Methodology:** This was a multicentric facility-based cross-sectional study with the objectives to assess the sociodemographic and economic status of the participants, to estimate the prevalence of the DPN using the screening methods, and to see the association with other factors. A predesigned semi-structured questionnaire, Semmes-Weinstein 10-g monofilament test, ankle reflexes, and vibration perception threshold test was used for the data collection and blood sugars levels were taken from the recent laboratory report. **Results:** Among 336, 202 (60.1%) were male and 134 (39.9%) were female. The prevalence of the DPN was 39.3% among them 28.9% in males and 10.4% in females, respectively. The other determinants of the participants, 264 (78.6%) had the Glycated hemoglobin (HbA1c) >7, 205 (61%) had a burning foot sensation, 124 (36.9%) of them were had numbness of the foot, almost 50% of them had pricking sensation in the foot and more than one-third (130) of them had callosity over foot. **Conclusions:** The study showed the severity of DPN was significantly associated with age, sex, duration of diabetes, HbA1c value, hypertension, and body mass index.

Keywords: Complications, diabetes type-2, peripheral neuropathy, prevalence

Introduction

India has one of the highest prevalence of type-2 diabetes mellitus (T2DM) in the world. The adverse effects of peripheral neuropathy (PN) are compounded by poor foot hygiene, improper footwear, and frequent barefoot walking, in such circumstances complications of foot infections and gangrene are a common cause of hospital admissions.[1] Diabetic PN (DPN) is a well-known micro-vascular complication of T2DM attributed to chronic hyperglycemia and is defined as the presence of peripheral nerve dysfunction in diabetics after exclusion of other causes.[2] Clinically, diabetic neuropathy is a destructive disease of the peripheral nerve leading to symptoms of pain or paraesthesia or problems arising from neurological deficit.[3]

The major problem with the development of DPN is that the changes are subtle and happen as people get older, people tend to ignore the signs of nerve damage, thinking it is just part of getting older.[4] Available evidence suggests that the presence of DPN among patients with diabetes leads to reduced quality of life, mainly attributable to the morbidity and mortality associated with DPN.[5] Hence, the problem of DPN demands the application of the concept of secondary prevention through early diagnosis and treatment. Screening for DPN in the clinical practice using a simple objective tool is essential, as the detection of the various soft and subtle signs of DPN at the earliest could minimize the damaging effects of this serious but manageable microvascular complication and in turn improve the quality of life of such patients. Foot disorders remain a major source of morbidity and a leading cause of hospitalization among people with diabetes mellitus (DM).[6]

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Methodology

A multi-centric, facility-based, cross-sectional study was done in rural areas of Kurnool district in Andhra Pradesh, India. The objective of the study was to estimate the prevalence of the DPN and its association with determinants and to assess the sociodemographic and economic status of the participants. The Kurnool district was divided into three divisions, and from each division, one primary health center (PHC) was selected randomly. The diabetic individuals were approached on the day of the noncommunicable disease clinic on that particular PHC. Those who were aged more than 30 years and diagnosed positive for type 2 diabetes at least 1-year duration with random blood sugar >200 mg/dL or fasting blood sugar >126 mg/dL as per the Indian Council of Medical Research guidelines 2005.[7] Those who were willing to participate were included in the study. The study period was from February 1 to March 30, 2017, i.e., 2 months. For the sample size calculation, we had taken the prevalence as 30%.[8] Using formula $4PQ/d^2$ and relative precision (Q) as 70 and degree of freedom (d) as 0.05 with the 10% of nonacceptance rate, the final sample size was around 336. Those having Type 1 diabetes, gestational DM, and maturity-onset diabetes of the young were excluded from the study. The ethical clearance was obtained before the start of the study. The participation information sheet and consent form were taken for permission to participate in the study.

Data collection and analysis

The sociodemographics information (name, age, sex, education, and occupation) and lifestyle characteristics (smoking and alcohol consumption) were collected by interviewing the participant. Biochemical parameters (fasting, postprandial glucose levels, and glycated hemoglobin [HbA1c] levels) were retrieved from the latest laboratory reports. Modified Kuppuswamy's scale-2017[9] was used to assess the socioeconomic status. Body mass index (BMI) was calculated as kg/m^2 and for Indian population[10] 18.5–22.9 was normal, 23–24.9 as overweight, and ≥25 was considered as obesity.

DPN was assessed using Semmes-Weinstein 10-g monofilament test,[2] ankle reflex and vibration perception thresholds test. The 10-g monofilament was placed perpendicular to the skin and pressure was applied until the filament just buckled with a contact time of 2 s. The 10-g monofilament was applied for ten points on each foot, and a "yes" response was indicative of the filament sensation. Eight correct responses out of 10 applications were considered as normal; 1–7 correct responses as reduced sensation, and no correct answer as absent sensation. In addition, ankle reflex were also assessed with a percussion hammer and recorded as either present or absent. The test of vibration was performed bilaterally using a 128 Hz tuning fork placed over the dorsum of the great toe on distal interphalangeal joint. A zero score showed that vibration sensation was intact while "0.5" represented a reduced sensation, and "1" was considered as lack of vibration sensation. The data were entered into Microsoft Excel and analysis was done in IBM SPSS Statistics 21.0 version (Armonk, NY: IBM Corp). The analysis was show with percentages in frequency tables, and association of the other determinants related to diabetes was shown with $P < 0.05$ as statistically significant using the Chi-square test.

Results

A total of 336 participants were involved in the study. Among them [Table 1], 202 (60.1%) are male and 134 (39.9%) were female with the mean age of 52 years in males and 50.8 years in females with standard deviation ± 9.2 and the age ranges from 33 to 72 years. As per the religion, more than 60% of them belonged to Hindus and one-fourth of them were Muslims and only 13% of them Christians. More than three-fourth (76.5%) were obese, out of which 157 (46.7%) were male and 100 (29.7%) were female and 45 (13.4%) of them were overweight and only 34 (10.1%) of them were normal. Almost 124 (36.9%) of the participants were had more than 6–10 years of exposure to diabetes and 134 (39.8%) of them were exposed to more than 10 years. Only 78 (23.2%) of them were exposed to diabetes <5 years. The smoking and alcohol only males were included because none of the females were not had that risk factor or they had hidden the truth even they had provided the privacy and confidence. More than 60% of them were smokers and 44% were taking alcohol. Almost all the participants are had the family history of diabetes out of which 233 (69.4%) were males and of the participants are having family history of diabetes and 43.4% of them are having a history of hypertension. More than 50% of the participants were belonging to middle and high school, 17.9% were belonging to intermediate, and nearly one-fourth of the participants belong to graduate and above. More than 55.3% belongs to the upper class, 16.6% belongs to upper middle class, and 20.4% belongs to lower middle class. Only 7.4% belong to upper lower class and none at the lower class.

More than three-fourth 264 (78.6%) of the participants had HbA1c more than seven and 15.4% of them were had 6.5–7.

Table 1: Distribution of participants according to the age, sex, religion, and risk factors of type-2 diabetes mellitus

	Male (%)	Female (%)	Total (%)
Age (years)			
30-40	29 (14.4)	25 (18.6)	54 (16.0)
41-50	56 (27.7)	41 (30.6)	97 (28.9)
51-60	72 (35.6)	43 (32.1)	115 (34.2)
>61	45 (22.3)	25 (18.6)	70 (20.9)
Total	202 (100)	134 (100)	336 (100)
Mean age	52.0	50.8	51.6
Religion			
Hindu	135 (66.9)	69 (51.4)	204 (60.7)
Muslim	51 (25.2)	37 (27.6)	88 (26.2)
Christian	16 (7.9)	28 (20.9)	44 (13.1)
Body Mass Index (BMI)			
Normal (>25)	17 (8.4)	17 (12.6)	34 (10.1)
Overweight (22.6-25)	28 (13.9)	17 (12.6)	45 (13.4)
Obesity (>22.5)	157 (77.7)	100 (74.6)	257 (76.4)
Family history of diabetes	233 (69.4)	103 (30.6)	336 (100)
History of hypertension	146 (43.4)	190 (55.6)	336 (100)

More than 205 (61.1%) had burning foot sensation, more than one-third 124 (36.9%) of them were had numbness of the foot, almost half of them were had pricking sensation in the foot and more than one-third 130 (38.7%) of them were had callosity over foot. The estimated prevalence of the DPN [Table 2] was more than 132 (39.2%) assessed with the reduced response on monofilament test, and 70 (20.8%) were had neuropathy on vibration perception. Almost 90% of the participants were had intact ankle reflex which is in good condition, and 80% of them were positive on vibration perception testing.

The overall prevalence [Table 3] of the DPN was 39.3% amongst them 28.9% in males and 10.4% in females, respectively. Males are having more PN compared to females, and it is statistically significant with $P < 0.005$ with odds ratio of 2.61 (95% confidence interval [CI] 1.63–4.2). The participants who were more than 50 years were had more PN than <50 years, and it was statistically significant with the odds ratio 0.61 (95% CI 0.40–0.95). With respect to BMI, the overweight and obese were having more PN than normal BMI with $P < 0.001$ and odds ratio of 2.59 (95% CI 1.59–4.23). Similarly, those with high HbA1c were had more PN than the normal HbA1c levels which is statistically significant with $P = 0.005$ and odds ratio of 4.81 (95% CI 2.96–7.80). As there was increase in the duration of diabetes, the PN was shown to be increased, and it is statistically highly significant with the $P < 0.001$ with the odds ratio of 0.23 (95% CI 0.13–0.39). Those who are having other associated disease such as hypertension will had more PN than those without and it was statistically significant (<0.05) with the odds ratio of 3.64 (95% CI: 2.31–5.74).

Discussion

The present study was conducted to estimate the prevalence of DPN among patients attending the outpatient department included 336 participants from the outpatient department in the rural settings of Kurnool district. The majority of them were aged more than 30 years with the mean age of 51.6 years with standard deviation of 9.3 and range of 33–72 years. Majority of the studies from India and abroad also taken the similar age group for assessing the prevalence of PN in the T2DM. The estimates of DPN prevalence in India vary widely from 9.6% to 78% in different populations.[10-13] The prevalence of DPN was found to be 39.3% in the present study which is higher when compared to the other studies from India which is 19.1%[14] and 29.2%,[15] respectively. Similar studies from India,[11] Nahla Khawaja[13] was reported the same estimates of the prevalence of DPN. This could be attributed to different types of diabetes (e.g., type 1 and type 2 diabetes), genetic predisposition, age of onset of diabetes, existing healthcare facilities, sample selection, different diagnostic criteria used (pin-prick perception, clinical signs and symptoms, and quantitative sensory tests or electrodiagnostic tests). The difference in the prevalence could probably be attributed to differences in the population studied, duration of diabetes or the severity of hyperglycemia in different studies.

Table 2: Distribution of type-2 diabetes mellitus according to the monofilament test, ankle reflex, and vibration perception test

Variable	*n* (%)
Monofilament test	
Normal (10)	204 (60.7)
Reduced response (1-7)	132 (39.2)
Absent (0)	0 (0)
Vibration perception test	
Present	266 (79.2)
Absent	70 (20.8)
Ankle reflex	
Present	296 (88.1)
Absent	40 (11.9)

The present study found statistically significant association between age, sex, BMI, duration of diabetes, and hypertension and the odds of DPN, which was observed similarly in another prevalence study by Pradeepa *et al*.[16] In a cross-sectional study by D'Souza *et al*.,[17] an increasing prevalence of DPN was associated with an increase in the risk of painful DPN. Thus, earlier screening is also required for preventing or delaying DPN. Increasing age, longer duration of diabetes, dyslipidemia, and the presence of other microvascular complications were found to be significantly associated with DPN in the present study. Other studies had reported a significant relation between age and the duration of diabetes on DPN.[18,19] In the present study majority (55%) were belong to the upper class 16.6% were belong to upper middle and 20.5% were belong to lower middle class and we had similar studies from India and abroad.[20]

In the present study, we found that males are having the DPN more than the females and it is statistically significant with a similar study showing that males being at higher risk in the Diabetes Control and Complications Trial.[21] The results in the present study shown that 19.7% of participants fell under the moderate and severe neuropathy with the monofilament test, and chances of getting foot ulcers and amputations in the near future if not taken appropriate treatment.

The prevalence of microvascular complications was higher in the group of patients with sex, HbA1 c >7%, duration of diabetes, and hypertension similar study done by Shera *et al*.[14] also reported that the HbA1c levels more than 8 were had higher microvascular complications. The results of this study, demonstrating that advancing age is associated with an increased risk of developing DN in T2DM patients, emphasize the necessity of an intensified, proactive screening for DN in elderly patients with T2DM. Similar studies from Karki *et al*.,[18] Ashok *et al*.,[19] and Karki *et al*.[11] showed the age, sex, BMI, duration, and hypertension also contributed in the risk factors for the increase in the DPN. The results of this study, demonstrating that advancing age is associated with an increased risk of developing DN in T2DM patients, emphasize

Table 3: Distribution of peripheral neuropathy (as per Monofilament test) according to different variables

Variable		Present	Absent	Total	OR (95% CI)	*P*
Sex	Males	97 (28.9)	105 (31.2)	202 (60.1)	2.61 (1.63-4.2)	<0.005
	Females	35 (10.4)	99 (29.4)	134 (39.9)		
Age (years)	30-50	54 (16.1)	87 (25.8)	141 (41.9)	0.61 (0.40-0.95)	<0.03
	>50	98 (29.1)	97 (28.8)	195 (58.0)		
BMI	>23	176 (52.3)	56 (16.6)	232 (69.0)	2.59 (1.59-4.23)	0.001
	<23	57 (16.9)	47 (13.9)	104 (31.0)		
HbA1c	>7	162 (48.2)	60 (17.8)	222 (66.0)	4.81 (2.96-7.80)	0.005
	<7	41 (12.2)	73 (21.7)	114 (34.0)		
Diabetes duration	<5 years	26 (7.7)	52 (15.4)	78 (23.2)	0.23 (0.13-0.39)	<0.01
	>5 years	177 (52.6)	81 (24.1)	258 (76.7)		
Hypertension	Present	89 (26.5)	57 (15.2)	146 (41.7)	3.64 (2.31-5.74)	<0.05
	Absent	57 (16.9)	133 (41.4)	190 (58.3)		

CI: Confidence interval, HbA1c: Glycated hemoglobin, BMI: Body mass index, OR: Odds ratio

the necessity of an intensified, proactive screening for DN in elderly patients with T2DM.

Limitations

This was a facility-based cross sectional study including only the diabetics attending the hospitals for follow-up and management. Hence, cause effect relationship cannot be established and the findings cannot be generalized. The use of microfilament is less accurate (compared to biothesiometer) at diagnosing PN.

Conclusions

The severity of DN was significantly and positively associated with age, sex, duration of diabetes, HbA1c value, hypertension, and BMI. Health-care facilities should incorporate foot care education and services among other routine services being provided to diabetic patients.

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Conflicts of interest

There are no conflicts of interest.

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