ORIGINAL RESEARCH ARTICLE

Prevalence of Diabetic Peripheral Neuropathy among Type-2 Diabetics in an Urban Slum of Bangalore, India

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ABSTRACT

Background: Community-level data on diabetic peripheral neuropathy (DPN) in underserved urban slums are limited. The aim of this study was to estimate the prevalence of DPN and identify associated factors among adults with type 2 diabetes mellitus (T2DM).

Methods: A community-based cross-sectional study was conducted from August 2022 to January 2024 among 300 adults aged ≥35 years with T2DM (≥2 years duration) in an urban slum of Bengaluru. Participants were selected by convenience sampling. Data on socio-demographic, clinical, and lifestyle variables were collected using a semi-structured questionnaire. DPN was assessed using the Michigan Neuropathy Screening Instrument. Multivariate logistic regression identified independent predictors; adjusted odds ratios (AOR) with 95% confidence intervals (CI) were reported.

Results: The prevalence of DPN was 18.7% (56/300). Independent predictors included age ≥60 years (AOR=2.87; 95% CI: 1.58–5.22; p<0.001), illiteracy (AOR=2.34; 95% CI: 1.28-4.27; p=0.006), sedentary occupation (AOR=2.19; 95% CI: 1.12-4.27; p=0.022), diabetes duration ≥10 years (AOR=2.61; 95% CI: 1.12-6.07; p=0.026), and hypertension (AOR=1.87; 95% CI: 1.01–3.44; p=0.046). Gender, body mass index, tobacco, and alcohol use were not significant after adjustment.

Conclusion: Nearly one-fifth of adults with T2DM had DPN. Older age, low educational status, sedentary work, longer diabetes duration, and hypertension are key correlates, supporting targeted screening and risk stratification in urban slum populations.

Keywords: Diabetic Peripheral Neuropathy, Type 2 Diabetes Mellitus, Urban Population, Cross-Sectional Studies, Hypertension, Sedentary Behavior

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Introduction

Non-Communicable Diseases (NCDs) such as heart disease, stroke, cancer, diabetes and chronic respiratory illnesses account for the majority of deaths and long-term illness worldwide, responsible for approximately 74% of all global mortality and disease burden.[1] Diabetes mellitus encompasses a group of metabolic syndromes characterized by chronic hyperglycaemia resulting from defects in insulin secretion, insulin action, or both.[2] Data from the International Diabetes Federation (IDF) indicate a rising global burden of diabetes, with 589 million adults affected in 2024, projected to increase to 853 million by 2050.[3] India accounts for approximately one in seven adults living with diabetes worldwide.[4] According to the National Family Health Survey-5 (2019-21), in Karnataka, elevated random blood glucose levels (≥140 mg/dL) or current use of antidiabetic medication were observed in 15.6% of men and 14.0% of women aged ≥15 years.[5]

DPN is a common complication of diabetes in which chronic hyperglycaemia damages peripheral nerves, leading to a gradual loss of protective sensation, typically in a distal symmetrical pattern.[6] Loss of pain, pressure, and temperature sensation allows minor foot injuries to go unnoticed, increasing the risk of delayed wound healing and foot ulcer formation.[7] Progressive neuropathy may result in motor weakness and gait abnormalities, contributing to skin breakdown, chronic wounds, and infected ulcers, which may lead to non-traumatic lower-limb amputations.[8] Since most studies on DPN were from institutional settings,[9,10] the true community burden, particularly among underserved populations may be missed where access to healthcare is constrained and risk factors for diabetes complications may be more prevalent.[11] Hence, we may miss those with undiagnosed in the community. Following these gaps, there is a need for field studies to generate community-level estimation of DPN prevalence and to find the associated risk factors among people with type 2 diabetes in urban slum settings.

Methodology

This study was conducted in the urban field practice area of Bangalore Medical College and Research Institute (BMCRI), Ward-118, between August 2022 and January 2024. The objectives are to estimate the prevalence of DPN among adults with type 2 diabetes mellitus (T2DM) and to find associated factors. Sample size was calculated based on a reported DPN prevalence of 23% from a Tamil Nadu study[12] with a 5% margin of error and 95% confidence interval and the sample size arrived to be 272. With a 10% non-response rate, the final sample size arrived to be 300. Adults aged 35 years and above with a confirmed diagnosis of type 2 diabetes mellitus for at least two years and willing to provide informed consent were included Diagnosis of type 2 diabetes mellitus was based on fasting plasma glucose ≥126 mg/dL, random plasma glucose ≥200 mg/dL with classic symptoms, or HbA1c ≥6.5%.[2] Diabetic peripheral neuropathy was defined as peripheral nerve dysfunction attributable to diabetes after exclusion of other causes.[13] Convenience sampling method has been used to recruit the participants. Each household were visited in all three sectors of Ward-118 and took the eligible individuals to participate in the study as and when they were available. Data were collected by the investigator through house-to-house interviews using a pre-designed semi-structured questionnaire covering socio-demographic details, diabetic profile, and behavioural habits. Socioeconomic status was assessed using the Modified Kuppuswamy Scale.[14] Physical activity classification followed WHO recommendations.[15] Current alcohol and tobacco use was defined as any consumption within the past one month; those who had quit for more than six months or had never used were classified as non-users.[16] BMI classification was based on Asia-Pacific cut-offs.[17] Hypertension was defined according to JNC-7 criteria.[18]Anthropometric calculations such as height, weight and waist circumference were measured using standard techniques. The Michigan Neuropathy Screening Instrument (MNSI) was employed to identify DPN.[19] This MNSI instrument consists of two components: a 15-item symptoms questionnaire, which is self-administered and includes yes/no questions comprising foot sensation, pain, numbness, and temperature sensitivity; and a clinical foot examination, which involves inspection for deformities, dry skin, calluses, infections, or ulcerations, vibration testing at the dorsum of the great toe, ankle reflex assessment using the Jendrassic maneuver, and monofilament testing. Each item was scored according to the standard MNSI protocol, and a clinical score ≥2 on either foot was considered indicative of DPN.[19] Training in MNSI administration was received by an investigator from a physician experienced in diabetic foot evaluation.

Data were analysed using SPSS version 29 proportions and percentages were used to present the Descriptive statistics. Associations between DPN and independent variables were first assessed using the Chi-square test, with a significance threshold of $p < 0.05$. Variables with $p < 0.2$ in bivariate analysis were selected for multivariate logistic regression models and results were presented as Adjusted Odds Ratios (AORs) with 95% confidence intervals.

Ethical approval was obtained from the Institutional Ethics Committee of BMCRI (No: BMCRI/PG/213/2022-23).

Results

300 participants with type 2 diabetes mellitus were included in the study. The demographic characteristics are summarized in Table 1. Most participants were aged 35-59 years (67.0%). 67.0% of the study population were females.

Table 1: Demographic profile of participants

Demographic Variables	Participants (%)
Age (years)	
35-59	201 (67)
≥60	99 (33)
Sex	
Male	99 (33)
Female	201 (67)
Education status	
Literate	136 (46.3)
Illiterate	164 (54.7)
Occupation	
Employed	167 (55.7)
Unemployed	133 (44.3)
Socio-economic status	
Class I+II+III	22 (7.33)
Class IV	220 (73.33)
Class V	58 (19.33)

Table 2: Lifestyle and Diabetic Profile (N = 300)

Variable	Participants (%)
Type of work	
Non-sedentary (Moderate/Heavy)	77 (25.7)
Sedentary	223 (74.3)
Doing Physical activity	99 (33)
Duration of Diabetes (years)	
2-9	246 (82)
≥10	54 (18)
Blood Pressure	
Normotensive	139 (46.3)
Hypertensive	161 (53.7)
BMI category	
Normal/Underweight	42 (14)
Overweight/Obese	258 (86)
Family history of diabetes	92 (30.66)
Consuming Tobacco	87 (29)
Consuming Alcohol	53 (17.67)

Table 3: DPN prevalence (N=300)

DPN Status	Participants (%)
DPN Negative	244 (81.33)
DPN Positive	56 (18.67)

Most participants were unemployed (44.3%) and 73.3% belonged to socio-economic class IV. Illiterate participants comprised 54.7%.

Lifestyle and clinical characteristics are presented in Table 2. The majority were involved in sedentary work (74.3%). Regular physical activity was reported by 33.0% of participants. Duration of diabetes was 2-9 years in 82.0%. Hypertension was present in 53.7%. BMI analysis showed that 86.0% were overweight or obese. A positive family history of diabetes was reported by 30.7%, tobacco consumption by 29.0%, and alcohol consumption by 17.7%.

The prevalence of DPN, assessed using MNSI, was 18.7% (n = 56) and absent in 81.3% (n = 244) of participants (Table 3).

Bivariate associations between participant characteristics and DPN are shown in Table 4. Reference categories are marked as "Ref" for each variable. Exact p-values to three decimal places are reported. In bivariate analysis, significant associations with DPN were observed for the following variables: age ≥60 years ($p < 0.001$), illiteracy ($p = 0.002$), unemployment ($p = 0.018$), sedentary work ($p = 0.016$), duration of diabetes ≥10 years ($p < 0.001$), hypertension ($p = 0.046$), physical inactivity ($p = 0.017$), and alcohol use ($p = 0.045$). Gender ($p = 0.880$), socio-economic status ($p = 0.850$), BMI category ($p = 0.320$), family history of diabetes ($p = 0.061$), and tobacco use ($p = 0.061$) were not statistically significant in bivariate analysis.

Variables with $p < 0.20$ in bivariate analysis were included in multivariate logistic regression. Table 5 shows the Adjusted Odds Ratios (AORs) with 95% Confidence Intervals (CI) and exact p-values. Reference categories are explicitly indicated. On multivariate analysis, the following variables remained significantly associated with DPN: age ≥60 years, illiteracy, sedentary work, diabetes duration ≥10 years, and hypertension. Physical inactivity and tobacco use did not retain statistical significance in the adjusted model.

DISCUSSION

In this population, the prevalence of **DPN** was **18%.** Previous Indian studies reported a 15-30% prevalence of DPN, indicating variability based on population characteristics.[20-22]

Our findings show a significant association between age ≥60 years and DPN, with this group having nearly triple the odds of developing the condition compared to those aged 35-59 years (AOR = 2.87; 95% CI: 1.58-5.22; $p < 0.001$). This finding is relatable to other studies showing higher neuropathy prevalence among older adults, most likely due to chronic hyperglycemia, oxidative stress, microvascular changes and longer diabetes duration.[23,24]

Also, a female predominance (67.85% of DPN cases) was observed in this study, although the association was not statistically significant after adjustment (AOR = 1.12; 95% CI: 0.61-2.05; $p = 0.708$). higher rates in females may imitate differences in healthcare access, health-seeking behavior, glycemic control, and awareness, rather than inherent biological susceptibility.[25]

Educational status showed significance in the multivariate model (illiterate vs. literate: AOR = 2.34; 95% CI: 1.28-4.27; $p = 0.006$), reflecting the importance of health literacy in self-management of the condition. Likewise, unemployment was associated with DPN in bivariate analysis ($p = 0.018$) but not significant after adjustment, signifying that some effects were confounded by education, sedentary behaviour, and SES. Lower socio-economic status (Class IV and V) shown increased crude prevalence but not shown as significant in the AOR model, possibly may be due to other lifestyle and clinical factors could mediated the risk.

Table 4: Bivariate associations with DPN (Unadjusted OR, 95% CI & p-values)

Variables	DPN Present (n = 56) (%)	DPN Absent (n = 244) (%)	Unadjusted OR (95% CI)	Exact p-value
Sex				
Male (Ref)	18 (32.143)	81 (33.197)	Reference (1)	
Female	38 (67.857)	163 (66.803)	0.95 (0.53-1.69)	0.880
Age Group				
35-59 (Ref)	24 (42.857)	177 (72.541)	Reference (1)	
≥60	32 (57.143)	67 (27.459)	3.52 (1.93-6.41)	<0.001
Education				
Literate (Ref)	15 (26.786)	122 (50.000)	Reference (1)	
Illiterate	41 (73.214)	122 (50.000)	2.73 (1.43-5.19)	0.002
Occupation				
Employed (Ref)	23 (41.071)	143 (58.606)	Reference (1)	
Unemployed	33 (58.929)	101 (41.394)	2.03 (1.12-3.66)	0.018
Type of Work				
Non-sedentary (Ref)	7 (12.500)	70 (28.689)	Reference (1)	
Sedentary	49 (87.500)	174 (71.311)	2.82 (1.22-6.52)	0.016
Socio-economic Status				
Class I+II+III (Ref)	5 (8.929)	17 (6.967)	Reference (1)	
Class IV & V	51 (91.071)	227 (93.033)	0.76 (0.27-2.17)	0.850
Duration of Diabetes				
2-9 yrs (Ref)	33 (58.929)	213 (87.295)	Reference (1)	
≥10 yrs	23 (41.071)	31 (12.705)	4.80 (2.59-8.88)	<0.001
Hypertension				
Normotensive (Ref)	19 (33.929)	120 (49.180)	Reference (1)	
Hypertensive	37 (66.071)	124 (50.820)	1.83 (1.01-3.36)	0.046
Family History				
No (Ref)	34 (60.714)	179 (73.361)	Reference (1)	
Yes	22 (39.286)	65 (26.639)	1.91 (0.97-3.97)	0.061
Tobacco Use				
No (Ref)	34 (60.714)	179 (73.361)	Reference (1)	
Yes	22 (39.286)	65 (26.639)	1.91 (0.97-3.97)	0.061
Alcohol Use				
Non-user (Ref)	44 (78.571)	157 (64.344)	Reference (1)	
User	12 (21.429)	87 (35.656)	0.49 (0.25-0.96)	0.045
Physical Inactivity				
Yes (No activity)	44 (78.571)	157 (64.344)	2.14 (1.15-4.00)	0.017
No (Active) (Ref)	12 (21.429)	87 (35.656)	Reference (1)	
BMI Category				
Normal/Underweight (Ref)	3 (5.357)	9 (3.689)	Reference (1)	
Overweight/Obese	53 (94.643)	235 (96.311)	2.15 (0.63-7.40)	0.320

*CI: Confidence interval, BMI: Body mass index, OR: Odds ratio

Table 5: Multivariate Logistic Regression showing factors independently associated with Diabetic Peripheral Neuropathy (DPN)

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	p-value
Age ≥60 years vs 35-59 (Ref)	2.87	1.58 - 5.22	<0.001
Illiteracy vs Literate (Ref)	2.34	1.28 - 4.27	0.006
Sedentary Occupation vs Non-sedentary (Ref)	2.19	1.12 - 4.27	0.022
Diabetes Duration ≥10 yrs vs 2-9 yrs (Ref)	2.61	1.12 - 6.07	0.026
Hypertension vs Normotensive (Ref)	1.87	1.01 - 3.44	0.046

DPN was strongly associated with occupational physical activity. higher prevalence among sedentary participants (74.3%) and an AOR of 2.19 (95% CI: 1.12-4.27; p = 0.022), highlights that physical inactivity as an independent risk factor. This inactivity can exacerbate insulin resistance, glycemic dysregulation, obesity, and microvascular dysfunction, which could have contributed to the occurrence of peripheral nerve damage. Consistent physical activity showed a protecting trend in bivariate analysis (p = 0.045).[26]

DPN was significantly associated with hypertension (AOR = 1.87; 95% CI: 1.01-3.44; p = 0.046). This association is biologically plausible, as hypertension induces vascular and endothelial damage, increases oxidative stress, and promotes nerve ischemia and axonal atrophy, ultimately leading to myelin thinning.[27]

Longer duration of diabetes (≥10 years) remained a significant risk predictor of DPN in this study (AOR = 2.61; 95% CI: 1.12-6.07; p = 0.026). Uncontrolled

chronic hyperglycemia over the time contributes to glycation of neuronal proteins, oxidative stress, and microvascular complications, which biologically leads to the observed association.[28,29]

Diabetes history in the family, tobacco usage, and consumption of alcohol did not show significant associations with DPN in multivariate models.

Overall, these results highlight that age of the participants, education level, occupational physical activity, duration of diabetes, and HTN are independently associated with DPN in this urban slum population. Multivariate logistic regression was carried out to adjust for potential confounders and identify the factors independently associated with DPN. After adjustment, age ≥60 years, illiteracy, sedentary occupation, longer duration of diabetes, and HTN remained significant. Thus, many factors that were significant on bivariate analysis lost their significance in the multivariate model, signifying confounding or interaction among predictors.

The detected associations are constant with both national and international literature, highlighting the importance of modifiable lifestyle and metabolic factors for public health interventions. Even though cross-sectional design limits causal inference, these results can identify groups at higher which eventually support screening and preventive strategies in resource-constrained urban settings.

Limitations

Since this as a cross-sectional study will limit the ability to infer causality between risk factors and DPN. Also, there could be misclassification because of using the MNSI to detect DPN, a validated screening tool, rather than diagnostic confirmation with nerve conduction studies, which may lead to misclassification. recall and reporting bias may have arisen for self-reported variables such as physical activity, alcohol, and tobacco use. Lastly, the use of convenience sampling method in an urban slum setting limits the generalizability of the findings to other populations or rural areas.

Conclusion

In this study of 300 Type 2 diabetes adult population from an urban slum, we found that 18% among them are affected by DPN. Multivariate analysis finds that older age, illiteracy, sedentary jobs, longer diabetes duration, and HTN as factors independently associated with DPN. This highlights that these factors are key correlates of DPN in this population.

Recommendations

Based on the findings of this study, certain population groups whom identified with factors associated with DPN appear to be at higher risk. Hence, forthcoming research could focus on these risk factors to better recognize the underlying mechanisms and temporal relationships. These results suggested the areas for further investigation rather than tested interventions. And also, community-level studies like this may support to inform targeted screening priorities and health awareness initiatives.

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Availability of Data: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Non-use of Generative AI Tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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