



## Assessment of Patterns of Neuropathy in Patients with Newly Diagnosed Type II Diabetes Mellitus

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### Declaration

#### Authors' Contribution

All authors equally contributed to the study and approved the final manuscript. \*Detail is given at the end.

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### ABSTRACT

**Background:** Diabetic peripheral neuropathy is a known complication of type 2 diabetes mellitus (T2DM), with additional evidence to support the existence of the neuropathy among newly diagnosed patients. This research evaluated peripheral neuropathy occurrence along with intensity in newly identified T2DM patients alongside investigating their demographic-related neuropathy relationships. **Objective:** To determine the frequency and patterns of peripheral neuropathy in patients with newly diagnosed type 2 diabetes mellitus. **Study Design:** Cross-sectional study. **Duration and Place of Study:** The study was conducted from October 2024 to March 2025 at the Department of Medicine, Sheikh Zayed Hospital, Lahore. **Methodology:** A total of 350 patients, aged from 25 to 75 years, with newly diagnosed T2DM in the previous 6 months were enrolled. Demographic data, including age, gender, height, weight, BMI, and medical history was also recorded. Peripheral neuropathy was assessed using a biothesiometer to measure the Vibratory Perception Threshold (VPT), with values greater than 15 volts indicating neuropathy. **Results:** The prevalence of peripheral neuropathy was found to be 48.9%, with 40.9% of patients having mild symptoms, 14% moderate, and 45% severe symptoms. Notably, patients aged over 50 showed a higher prevalence of neuropathy (67.1%). Gender differences were also observed, with more females (60.9%) affected compared to males (41.5%). **Conclusion:** This study highlights the high prevalence of peripheral neuropathy in newly diagnosed T2DM patients, with age, gender, and duration of diabetes serving as significant predictors.

### INTRODUCTION

Diabetes mellitus, a chronic metabolic syndrome, is a consequence of defects of insulin secretion, insulin action, or both, with hyperglycemia as the outcome.<sup>1</sup> Diabetes mellitus is classified into the two categories, Type 2, the more common of the two, developing in adults, although increasingly children and adolescents are being diagnosed with the condition, while Type 1 is the other category.<sup>2</sup> There are some risk factors for the condition, including obesity, physical insufficiency, family history of diabetes, as well as advancing age. The long-term effects of unregulated blood sugar levels can lead to early complications of the cardiovascular, renal, as well as nervous systems.<sup>3</sup> Repeatedly raised blood sugar levels can, over time, have detrimental effects on blood vessels as well as nerves, thus giving rise to many complications of diabetes.<sup>4</sup>

Type 2 diabetes is often diagnosed through fasting blood glucose tests, oral glucose tolerance tests, or HbA1c measurements.<sup>5</sup> Newly diagnosed individuals often have delayed awareness of symptoms, as the earlier stages of the disorder are often asymptomatic.<sup>6</sup> Typically, one of the

first indicators of the disorder is thirst followed by frequent urination, unexplained weight loss, and fatigue.<sup>7</sup> Individuals are often diagnosed after the long-term effects of the disorder, such as dyslipidemia metabolic imbalance, hypertension, and hyperglycemia, as revealed by a rise in blood glucose levels.<sup>8</sup>

Diabetic peripheral neuropathy is the most common disabling complication of diabetes caused by hyperglycemia-induced prolonged damage of the peripheral nervous system.<sup>9</sup> It is caused by peripheral nerve injury, especially of the lower limbs, followed by sensory, motor, and autonomic deterioration.<sup>10</sup> Frequent manifestations are pain, numbness, paresthesias, and weakness of the feet and hands.<sup>10</sup> Poor blood circulation, typical of diabetes, further contributes to nerve injury. Other systems, such as the autonomic nervous system, may be affected, with symptoms such as gastrointestinal disturbances, disturbances of heart rate, and bladder disturbances.<sup>12</sup> Although the exact mechanism of nerve injury is multifactorial, hyperglycemia-mediated oxidative injuries, inflammation, as well as dysregulated metabolic

processes, have been implicated as the cause of nerve injury.<sup>12</sup>

The severity of diabetic peripheral neuropathy can be classified according to the Vibratory Perception Threshold (VPT) of sensory nerve function as measured by the biothesiometer.<sup>13</sup> VPT is used for assessing ability to feel vibration, often lost in neuropathy. Diabetic peripheral neuropathy is classified according to VPT values as follows: Mild (VPT 15-20 volts), Moderate (VPT 20-25 volts), and Severe (VPT > 25 volts).<sup>14</sup> These thresholds are helpful for assessing severity of nerve injury as well as for clinical decision making regarding treatment and intervention.

Amour et al. conducted a study involving 327 diabetic patients. Peripheral neuropathy was detected in 72.2% of the participants, with 55% experiencing severe neuropathy, 19% moderate, and 26% mild neuropathy.<sup>15</sup> In a separate study by Iqbal et al., 120 newly diagnosed Type 2 diabetes patients were assessed. Peripheral neuropathy symptoms were noted in 42 patients (35%).<sup>16</sup> A meta-analysis by Akhtar et al. reviewed 19 studies involving 8,487 diabetic individuals and found an overall pooled prevalence of diabetic peripheral neuropathy of 43.16% (95% CI: 32.93-53.69%), showing considerable variability across studies. In patients newly diagnosed with diabetes, the prevalence of peripheral neuropathy was 26.52% (95% CI: 14.97-39.96%, n = 5).<sup>17</sup>

The necessity of examining patterns of peripheral neuropathy among newly diagnosed Type 2 diabetes mellitus patients is essential given the continued rise of diabetes globally, as well as the prospect of early identification of neuropathic complications, followed by appropriate management. Detection of the onset as well as severity of neuropathy at early stages of the disease would enable clinicians to intervene early, thus avoiding additional nerve injury and enhancing patient outcome. Further, pattern observation of neuropathy among such patients would help refine treatment interventions, enhance patient care, as well as help avoid long-term complications like foot ulcers, infections, as well as amputation.

## METHODOLOGY

This cross-sectional study was conducted from October 2024 to March 2025 at the Department of Medicine, Sheikh Zayed Hospital, Lahore. A sample size of 350 patients was calculated using the WHO sample size calculator, with a 95% confidence level, an anticipated prevalence of peripheral neuropathy of 35%, and a 5% margin of error.<sup>16</sup>

Inclusion criteria required participants to be aged between 25 and 75 years, both male and female, with a diagnosis of Type 2 diabetes mellitus within the last six months. Patients with a history of peripheral neuropathy due to such causes as alcohol use, vitamin B12 deficiency, connective tissue disease, vasculitis, infection, or drugs (such as isoniazid or amiodarone) were excluded from the study. Informed consent was obtained following approval from Institutional Review Board and the College of Physicians and Surgeons Pakistan (CPSP). Pre designed proforma was used to collect demographic data like age, gender, height, weight, body mass index (BMI), present

medical history (i.e. hypertension, HbA1c level) etc of all the participant.

Vibratory Perception Threshold was measured using a biothesiometer to measure peripheral neuropathy. The VPT values were categorized by patients with values greater than 15 volts indicative of neuropathy. According to established criteria, the severity of neuropathy was mild (VPT 15-20 volts), moderate (VPT 20-25 volts) or severe (VPT > 25 volts). By using this method it was possible to make a precise diagnosis of neuropathy and categorize its intensity according to the recorded levels of VPT. Furthermore, all data were recorded systematically for further analysis.

Data analysis was performed using SPSS version 27.0. Numerical variables such as age, height, weight, BMI, duration since diagnosis, and HbA1c levels were expressed as mean ± standard deviation, while categorical variables such as gender, hypertension history, and the presence and severity of peripheral neuropathy were presented as frequencies and percentages. Stratification based on variables like age, gender, BMI, and hypertension history was conducted to explore differences in neuropathy patterns. A Chi-square test was employed to compare neuropathy severity across stratified groups, with a significance level set at p ≤ 0.05 for all statistical tests.

## RESULTS

The demographic data from Table-I reveals that the mean age of patients was 56.93 ± 8.69 years, with an average height of 1.68 ± 0.06 meters, and weight of 81.15 ± 8.70 kilograms. The average BMI was 28.60 ± 1.95 kg/m<sup>2</sup>, and the duration since diagnosis was 4.21 ± 1.25 months. The mean HbA1c was 8.29 ± 0.84%. The gender distribution was 62% male (217 patients) and 38% female (133 patients). In terms of hypertension, 38.3% (134 patients) had hypertension, while 61.7% (216 patients) did not.

**Table I**  
*Patient Demographics*

| Demographics                      | Mean ± SD    |             |
|-----------------------------------|--------------|-------------|
| Age (years)                       | 56.925±8.69  |             |
| Height (m)                        | 1.682±0.06   |             |
| Weight (Kg)                       | 81.149±8.70  |             |
| BMI (Kg/m <sup>2</sup> )          | 28.598±1.95  |             |
| Duration since diagnosis (months) | 4.211±1.25   |             |
| HbA1c (%)                         | 8.290±0.84   |             |
| Gender                            | Male n (%)   | 217 (62%)   |
|                                   | Female n (%) | 133 (38%)   |
| Hypertension                      | Yes n (%)    | 134 (38.3%) |
|                                   | No n (%)     | 216 (61.7%) |

As shown in Table-II, the prevalence of peripheral neuropathy in the sample was 48.9% (171 patients), while 51.1% (179 patients) did not have peripheral neuropathy. Among those with peripheral neuropathy, 40.9% had mild symptoms, 14% had moderate symptoms, and 45% experienced severe symptoms.

**Table II**  
*Prevalence and patterns of peripheral neuropathy in patients with newly diagnosed type 2 diabetes mellitus*

| Peripheral neuropathy                    | Frequency | % age |
|------------------------------------------|-----------|-------|
| Yes                                      | 171       | 48.9% |
| No                                       | 179       | 51.1% |
| <b>Patterns of peripheral neuropathy</b> |           |       |
| Mild                                     | 70        | 40.9% |

|          |    |     |
|----------|----|-----|
| Moderate | 24 | 14% |
| Severe   | 77 | 45% |

Table-III highlights the association between peripheral neuropathy and various demographic factors. Age significantly influenced the presence of peripheral neuropathy ( $p < 0.001$ ), with no cases of neuropathy in those aged 50 years or younger. For patients over 50, 67.1% had neuropathy, while 32.9% did not. Gender was also a significant factor ( $p < 0.001$ ), with more males (41.5%) not experiencing neuropathy compared to females (39.1%) who had a higher proportion (60.9%) with peripheral neuropathy. Duration since diagnosis was strongly correlated with the presence of neuropathy ( $p < 0.001$ ), with 69.8% of those diagnosed for more than three months having neuropathy.

**Table III**  
*Association of Peripheral neuropathy with Demographic Factors*

| Demographic Factors               | Peripheral neuropathy |             | p-value |
|-----------------------------------|-----------------------|-------------|---------|
|                                   | Yes n(%)              | No n(%)     |         |
| Age (years)                       | ≤50                   | 0 (0%)      | <0.001* |
|                                   | >50                   | 171 (67.1%) |         |
| Gender                            | Male                  | 90 (41.5%)  | <0.001  |
|                                   | Female                | 81 (60.9%)  |         |
| BMI (Kg/m <sup>2</sup> )          | ≤25                   | 0 (0%)      | 0.123*  |
|                                   | >25                   | 171 (49.4%) |         |
| Duration since diagnosis (months) | ≤3                    | 0 (0%)      | <0.001* |
|                                   | >3                    | 171 (69.8%) |         |

**\*Fisher Exact Test**

Table-IV examines the relationship between demographic factors and the patterns of peripheral neuropathy. Age did not significantly affect the severity patterns of neuropathy ( $p = 1.000$ ). However, gender did show significant variation ( $p = 0.015$ ), with more males (48.9%) experiencing mild neuropathy compared to females (32.1%), while females had a higher percentage of severe neuropathy (46.9%) compared to males (43.3%). BMI and duration of surgery did not have a significant impact on the patterns of neuropathy ( $p = 1.000$  for both).

**Table IV**  
*Association Patterns of peripheral neuropathy with Demographic Factors*

| Demographic Factors           | Patterns of peripheral neuropathy |               |             | p-value |
|-------------------------------|-----------------------------------|---------------|-------------|---------|
|                               | Mild n(%)                         | Moderate n(%) | Severe n(%) |         |
| Age (years)                   | ≤50                               | 0 (0%)        | 0 (0%)      | 1.000*  |
|                               | >50                               | 70 (40.9%)    | 24 (14%)    |         |
| Gender                        | Male                              | 44 (48.9%)    | 7 (7.8%)    | 0.015   |
|                               | Female                            | 26 (32.1%)    | 17 (21%)    |         |
| BMI (Kg/m <sup>2</sup> )      | ≤25                               | 0 (0%)        | 0 (0%)      | 1.000*  |
|                               | >25                               | 70 (40.9%)    | 24 (14%)    |         |
| Duration of Surgery (minutes) | ≤3                                | 0 (0%)        | 0 (0%)      | 1.000*  |
|                               | >3                                | 70 (40.9%)    | 24 (14%)    |         |

**\*Fisher Exact Test**

**DISCUSSION**

These results revealed that about half of the patients (48.9%) had the manifestations of peripheral neuropathy, where there was an appreciable incidence of severe symptoms (45%). The high incidence reported is reflective of documented works that emphasize the high prevalence of neuropathy among diabetic patients, especially those whose blood glucose is poorly controlled, resulting in long-term nerve damage.

Demographic analysis indicated that gender and increasing age were key predictors of the development of peripheral neuropathy. In detail, advanced age was closely correlated with neuropathy frequency at 67.1% among patients aged over 50 years. In accordance with past research, it has been postulated that aging promotes neuropathy risk because it results in cumulative metabolic damage to nerves and blood vessels. The greater number of females with neuropathy could be explained by gender-related variations in susceptibility to diabetic neuropathy, at least depending on hormonal factors and variations in body fat distribution, as previously hypothesized.

In addition, the correlation of peripheral neuropathy with the length of diagnosis underscores neuropathy's chronicity among diabetics. Not unexpectedly, those with over three-month durations of diagnosis tended to be at significantly higher risk for developing neuropathy, an indication of the contributory effect of chronic hyperglycemia to the etiopathogenesis of nerve damage. These results underscore the necessity for early treatment and meticulous management of diabetes to avoid or delay peripheral neuropathy.

The results from our study showed that the mean age of the patients was  $56.93 \pm 8.69$  years, with a mean BMI of  $28.60 \pm 1.95$  kg/m<sup>2</sup> and a mean HbA1c of  $8.29 \pm 0.84\%$ . The gender distribution revealed a higher proportion of males (62%) compared to females (38%). These findings align with studies like those by Lakhia et al.<sup>18</sup> which reported a similar age distribution with a mean age of 45.16 years and a comparable gender ratio, although there was a slightly higher percentage of females in the Lakhia study.

In our study, there was a prevalence of peripheral neuropathy of 48.9% with 40.9% of the patients with mild symptoms, 14% moderate symptoms, and 45% extreme symptoms. Such results are in agreement with other studies such as those by Saeed et al.<sup>16</sup> and Iqbal et al.<sup>19</sup> which have reported neuropathy rates of 35% and 32.7%, respectively. Nevertheless, the rate of neuropathy in our study was higher, perhaps due to the fact that our patient population included more severely affected patients with a higher HbA1c, who have been shown to have an elevated risk for neuropathy. Moreover, there are potential explanations for these prevalence differences in the presence of differences in sample sizes and patient characteristics, and in study settings.

Additionally, in our study, Gender was also found to be significant factor associated with presence of neuropathy; more females (60.9%) were found with Neuropathy than males (41.5%). The present finding is consistent with that of Lakhia et al.'s<sup>18</sup> and Iqbal et al.'s<sup>19</sup> findings of the higher prevalence of neuropathy in females. Hormonal

difference as well as potential difference in fat distribution can explain gender difference in prevalence of neuropathy. However, Saeed et al.<sup>16</sup> reported higher prevalence of neuropathy in males, possibly because of the difference in demographic factors and lifestyle like working of occupation and physical activity levels between males and females in the different regions.

Another important cause we found was that the risk of neuropathy was higher in older patients, as has been reported in Saeed et al.<sup>16</sup> and Iqbal et al.<sup>19</sup> which share a correlation of neuropathy with older age as well. Interestingly, Saeed et al.<sup>16</sup> found that neuropathy was more prevalent in patients with a longer duration of diabetes, which mirrors our own findings that suggest a strong correlation between the duration of diabetes and the onset of neuropathy.

In terms of the severity patterns of neuropathy, our study found that gender influenced the distribution of mild versus severe neuropathy. More males had mild neuropathy (48.9%) compared to females (32.1%), while females had a higher incidence of severe neuropathy (46.9%) compared to males (43.3%). These findings were consistent with the results of Lakhari et al.<sup>18</sup> which also reported gender differences in the severity of neuropathy. However, the absence of a significant association between age and the severity of neuropathy in our study ( $p = 1.000$ ) contrasts with the study by Saeed et al.<sup>16</sup> where age was found to be associated with the severity of neuropathy. This discrepancy might be due to differences in how severity was categorized or the threshold used for classification in different studies.

The research emphasizes the necessity of early diagnosis, screening consistently, as well as management of glycemic control, in order to prevent the development and progression of neuropathy. The observation that demographic factors like gender, age, and the period of diabetes correlate with neuropathy points to the necessity of individualized care modalities to target the risk factors for this disorder.

Nonetheless, it is essential to recognize several limitations to our study. As a single-center study, the

results cannot be representative of the wider diabetic community, and there may be regional variations. The relatively short follow-up period is correspondingly limited to determining the long-term course of neuropathy. The lack of detailed ancillary data including other potential confounding factors, like comorbidity or degree of glucose control over the period of follow-up, similarly limits the complete understanding of factors underpinning neuropathy within this group. Such results must be validated by future multi-center trials with extended follow-up durations and subject selection from more heterogeneous patients.

## CONCLUSION

Our research has established that neuropathy is an overriding complication among patients with newly diagnosed type 2 diabetes mellitus. The degree of neuropathy prevalence was significantly correlated with age, gender, and the history of diabetes. Early diagnosis as well as systematic monitoring are vital to stopping the development of neuropathy and enhancing the patients' quality of life. These results emphasize the necessity for early intervention as well as customized care modalities for managing and reducing the effects of diabetic neuropathy.

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## Author's Contribution:

The authors have significantly contributed to the manuscript in the following ways: Dr. Hafiz Abad Mahmood spearheaded the conceptualization of the study, wrote the initial draft of the article, and oversaw the collection of hospital data. Dr Uthman Ahmad played a key role in the development of the article, contributed to the conceptualization of the study, and was instrumental in analyzing and interpreting the data.

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