

# Clinical Features of Peripheral Neuropathy among Onset Type 2 Diabetes Mellitus: A Michigan Neuropathy Screening Instrument (MNSI) Approach

Rian Adi Pamungkas<sup>1</sup>, Andi Mayasari Usman<sup>2</sup>, Kanittha Chamroonsawasdi<sup>3</sup>

<sup>1</sup>Department of Nursing, Faculty of Health Sciences, Universitas Esa Unggul, Jakarta Indonesia

<sup>2</sup>Department of Nursing, Faculty of Health Science, Universitas Nasional Jakarta Indonesia

<sup>3</sup>Department of Family Health, Faculty of Public Health, Mahidol University Thailand

Email: [rian.adi@esaunggul.ac.id](mailto:rian.adi@esaunggul.ac.id)

Received July 11, 2022,

Revised 7 November, 2022,

Accepted 8 November, 2022,

Available online 28 February, 2023

## Abstract

**Introduction:** Neuropathy is one of the complications that can occur in patients with Type 2 Diabetes Mellitus, around 21.3% to 34.5%. Untreated neuropathy can lead to diabetic foot ulcers that can lead to amputation. This can be prevented by conducting early detection using a neuropathy screening instrument.

**Aim:** The study aimed to identify neuropathy symptoms through early examination of patients with type 2 diabetes using the Michigan Neuropathy Screening Instrument (MNSI).

**Method:** The descriptive study with a survey was approached in this study. One hundred respondents with type 2 diabetes mellitus were selected using the purposive sampling technique.

**Results:** The results showed that out of 100 patients had clinical symptoms of sensory neuropathy, such as pain and sensitivity disorders in the soles of the feet. In addition, autonomic neuropathy is in the form of cramps in the leg muscles. The level of neuropathy showed that from 100 patients, there were 59 respondents with low risk of neuropathy, 40 respondents with moderate risk, and 1 respondent with severe risk.

**Conclusion:** Patients with Diabetes, primarily Type 2, have various neuropathy symptoms such as impaired nerve function: numbness, burning, and hypersensitivity, which can lead to diabetic foot ulcers. Therefore, early detection of neuropathy prevention is essential.

*Keywords: Type 2 diabetes mellitus, Peripheral neuropathy, Clinical features, Michigan Neuropathy Screening Instrument.*

## Introduction

Neuropathy is a disease characterized by damage to the peripheral nervous system, causing the impaired function of the peripheral nerves in sending signals from organs to the brain and vice versa. Diabetic neuropathy is one of the complications that are often encountered in diabetic patients. The prevalence of diabetic neuropathy ranges from 21.3% to 34.5% among patients with type 2 Diabetes Mellitus (DM) (Ponirakis et al., 2021). Approximately 7% to 34.2% of type 1 diabetic patients (Walter-Höliner et al., 2018).

The most common symptoms found in cases of neuropathy in diabetic patients are numbness, tingling (Hwang et al., 2018), and weakness (Qureshi et al., 2017). These symptoms usually occur in the legs and spread proximally, which is the leading cause of disability worldwide (Qureshi et al., 2017). Diabetic neuropathy could affect the patient's quality of life due to pain in the legs (Timar et al., 2016), wounds on the leg (Bondor et al., 2016), even risk for amputation.

Uncontrolled blood sugar conditions and unhealthy lifestyle behaviors such as smoking and hypertension worsen neuropathy. Risk Factors In both major types of Diabetes, the prevalence and severity of Diabetes neuropathy increase with disease duration and age. Previous studies have shown that metabolic syndromes such as hypertension, abdominal obesity, low-density lipoprotein (HDL) levels, and hypertriglyceridemia are consistently associated with the development of neuropathy (Andersen et al., 2018). Therefore, the appropriate strategy must be applied to reduce neuropathy complications.

American Diabetes Association (ADA) recommended conducting an effective screening method to prevent neuropathy complications among Diabetes mellitus patients. However, effective screening methods are rarely used, resulting in delays in diagnosing diabetic neuropathy (Tavakoli et al., 2017). At the same time, this screening becomes a crucial step in preventing early complications of neuropathy for patients with diabetes mellitus. A study conducted in Indonesia showed that the most complication was diabetic neuropathy, as much as 54% (Ministry of Health Republic of Indonesia, 2018). Basic Health Research in Indonesia showed that most Diabetes neuropathy developed into diabetic neuropathy. A study reported that the incidence of Diabetes neuropathy reached about 30-60% then 10-20% have experience with non-diabetic neuropathy (Raskin et al., 2005; Zychowska et al., 2013). Therefore, early detection needs to conduct to solve the problems.

Previous research on the early detection of neuropathy for patients with Diabetes mellitus showed that early diagnosis and appropriate intervention are essential to prevent the development and progression of diabetic neuropathy (Carmichael et al., 2021). Another study also demonstrated the effectiveness of screening in detecting the presence of neuropathy (Pamungkas et al., 2022).

Although screening for neuropathy is essential in the early detection of diabetic complications and as a basis for determining subsequent interventions. However, in many health services, there are still many who do not carry out these routine activities. Therefore, some patients are delayed in diagnosing neuropathy (Tavakoli et al., 2017). This study aimed to identify the neuropathy symptoms using the early screening of the Michigan Neuropathy Screening Instrument. This instrument could be used to assess signs of neuropathy, where the evaluation is based on cranial nerve damage, muscle strength, loss of reflexes, and loss of sensation.

## **Methods**

A survey study was conducted within one month to identify the neuropathy symptoms using the early screening of the Michigan Neuropathy Screening Instrument. The samples in this study were type 2 diabetes mellitus which were selected based on inclusion criteria. One hundred adult populations with type 2 diabetes mellitus were involved and selected purposively. The inclusion criteria include 1) an adult population aged 45 - 65 years old; 2) No active diabetes foot ulcer; 3) They have not experienced amputation in both legs, and 4) willingness to participate in this study. Patients with chronic complications of Diabetes mellitus were excluded from this study. Before data collection was conducted, all samples received information regarding the objective of this study and the research procedure. Informed consent should be obtained from all patients willing to participate in this study.

The instrument used in this study includes 1) Demographic Data Questionnaire developed by the researcher. This questionnaire was used to assess the demographic data through direct patient interviews. 2) Michigan Neuropathy Screening Instrument Questionnaire. *Michigan Neuropathy Screening Instrument Questionnaire* was used to identify the neuropathy symptom among diabetes patients. This questionnaire was adopted from previous research, which consisted of 15 questions. Each question that shows symptoms of neuropathy is given a score of 1. Patients who do not show symptoms of neuropathy have a score of 0. Before being given to patients, the questionnaire was translated into Indonesian. A score of more than 7 indicates a risk of neuropathy in patients with Diabetes. The Cronbach alpha score was 0.82. It was considered a reliable instrument.

The data collection process was carried out for approximately one month, assisted by a research assistant. This research activity was carried out at the *Puskesmas*, and all patients involved in this study were asked to sign an informed consent form as participants in this study. In addition, researchers have explained the purpose of this research and the process of this research. Patients who agreed to participate in this study were then asked to fill out the Michigan Neuropathy Screening Instrument Questionnaire to assess the clinical picture of peripheral neuropathy. Collecting patient data is carried out for approximately 15 minutes, and each patient has the opportunity to fill out one questionnaire.

We analyze the data using descriptive statistics such as frequency distribution analysis that aims to describe the symptoms of autonomic neuropathy and sensory neuropathy in diabetic patients. This research has been through an ethical test from Esa Unggul University, Jakarta, No. 0202-20.183 / DPKE-KEP / FINALE / UEU / VII / 2020. All patients involved in this study have consented by signing the informed consent.

## **Results**

### **Demographic characteristic**

Table 1 showed that from 100 respondents in the Public Health Center, Kebon Jeruk Subdistrict, who did the initial examination of neuropathy aged 55-65 years more than the middle-aged (66-74) and the elderly (75-90). More than half of the samples in this study were included in the young adult age category 81 respondents (81%). All respondents in the study were married, with almost the same distribution of education for each level. Of the 100 respondents, 53% of patients had a family history of Diabetes, while only 47% had no family history of diabetes mellitus.

### **Features of Sensory Neuropathy**

#### **1) Pain responses in the nerves of the feet**

Table 2 describes the pain response in the nerves of the feet as one of the symptoms of neuropathy. Of the 100 respondents who were screened, 23% of respondents complained of burning pain in the soles of their feet. 26% feel pain at night, and 21% feel leg pain when walking. The results can be seen in figure 1 below.

#### **2) The sensitivity responses in the feet**

Table 3 describes the sensitivity symptoms in the patient's feet. Of the 100 patients who were screened, 44% of patients complained of numbness in the soles of their feet. However, almost all patients (99%) can still distinguish between hot and cold sensations on the soles of their feet.

**Features of autonomic neuropathy**

Table 3 describes other physical symptoms in the feet of patients with Diabetes mellitus that are associated with neuropathic symptoms. Nearly half of diabetic patients experience muscle, leg, and foot cramps (48%). Only 35% felt like their feet were prickling and characterized by dry and cracked skin on them (17%). Of the 100 patients who were screened, only 15% did not indicate a leg injury. While 85% of them have open wounds on their feet

**3) The level of neuropathy in the feet of patients with Diabetes mellitus based on the MNSI score**

Figure 2 describes the level of neuropathy in the feet measured using the MNSI score. The MNSI score found that 59 patients had a low risk of neuropathy. While 40 patients showed a moderate risk of neuropathic symptoms, and only one patient had a risk of severe neuropathy and the potential for foot ulcers.

**Table 1.** Demographic Data

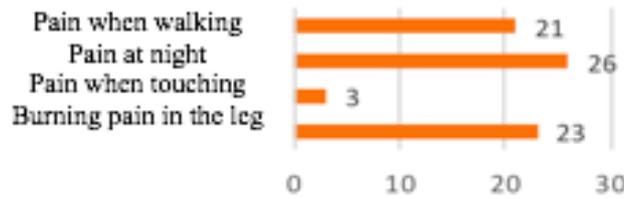
Data	Variables	N	%
Gender	Male	27	27
	Female	73	73
Blood glucose level	<200 mg/dl	56	56
	>200 mg/dl	44	44
Marital Status	Married	100	100
	Have no married	0	0
Education background	Un-literate	20	20
	Primary school	32	32
	Secondary school	18	18
	Tertiary school	20	20
	University level	20	20
Family history	Have Diabetes	53	53
	Have no diabetes	47	47
Age	Mean= 62.49	SD= 1.358	

**Table 2.** Sensitivity response in the feet

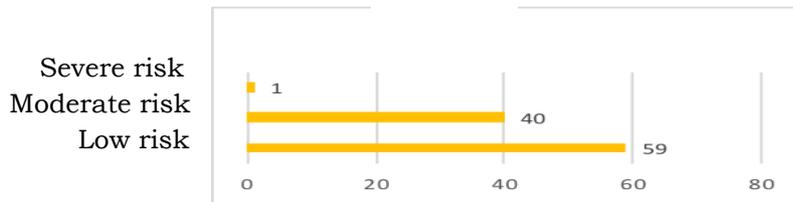
Symptoms	Patients' responses	N	%	
Sensitivity responses	Numbness	Yes	44	44
		No	56	56
Foot sensitivity when touched	Yes	11	11	
	No	89	89	
Sensation in distinguishing hot and cold	Yes	99	99	
	No	1	1	

**Table 3.** Features of autonomic neuropathy

Symptoms	Patient's Response	N	%	
Features of autonomic neuropathy	Cramps in muscles, legs, and feet	Yes	48	48
		No	52	52
A stabbing feeling in the patient's leg	Yes	35	35	
	No	65	65	
Open wound inpatient	Yes	15	15	
	No	85	85	
Feeling weak	Yes	48	48	
	No	52	52	
Dry and cracked skin on feet	Yes	17	17	
	No	83	83	



**Figure 1.** Pain Response in the Feet



**Figure 2.** Level of neuropathy on Diabetes feet based on MNSI score

**Discussion**

Neuropathy screening results showed that most diabetic patients are categorized as early elderly with ages 55–65 years. The majority of them are female. More than half of them (56%) can still control their blood sugar with levels <200 mg/dl. In comparison, 44% of them have sugar levels still above the average uncontrolled threshold >200mg/dl.

Uncontrolled type 2 diabetes mellitus was a significantly high neuropathy risk leading to a foot ulcer. Previous studies have shown that blood sugar levels are positively associated with neuropathy in patients with diabetes mellitus (Pamungkas et al., 2022). Another study showed that hemoglobin A1c (HbA1c) levels predictor diabetic neuropathy significantly (Tesfaye et al., 2005). The American Diabetes Association stated that adequate blood sugar control for patients with type 2 diabetes could reduce the risk of neuropathy by 5%-9% (Pop-Busui et al., 2017).

Pain in the feet is one of the neuropathy symptoms based on symptomatology criteria. The screening results among DM patients showed that some patients complained of pain in the legs' nerves, and some complained of pain at night and when walking. Several studies show that most diabetic patients with neuropathy complain of pain. A previous study described that using the DN4 instrument showed 65.3% of patients with type 1 and 2 DM have painful diabetic peripheral neuropathy, much higher than expected (Halawa et al., 2010). Another symptom found among DM is a burning feeling in the soles of the feet. This is in line with previous studies showing that a burning sensation in the soles of the feet is a symptom of neuropathy. Another study conducted in Bandung, Indonesia, showed that more than 50% of patients with DM complained of pain, which resulted in poor sleep quality of patients at night (Azhar et al., 2017).

Regarding foot sensitivity in patients with Diabetes mellitus, this condition is due to damage of the nerves distal part, especially the lower extremities with a symmetrical distribution. Thereby, it can extend to the proximal area. The screening results showed that almost half of patients suffering from Diabetes mellitus complained of numbness in the soles of their feet, but almost all patients could still distinguish between hot and cold sensations on the soles of their feet. A previous study showed that symptoms of neuropathy vary according to the class of

sensory fibers involved. Common initial symptoms are induced by the involvement of tiny fibers and include pain (an unpleasant burning sensation) (Freeman et al., 2014; Pop-Busui et al., 2017). In addition, diabetic neuropathy patients also sometimes have cramps in the muscles, legs, and feet and dry and cracked skin on the feet, which will be at risk of injury to the feet of Diabetes mellitus. This is due to high blood sugar. If you have a skin infection or poor circulation, this can also cause dry and itchy skin. This condition develops when you have high levels of fat in your blood.

The results MNSI score found that 59% of patients had a low risk of neuropathy. While 40 patients showed a moderate risk of neuropathic symptoms, and only one patient had severe neuropathy risk. This is accompanied by impaired nerve function, such as numbness, burning, and hypersensitivity. The motor function disorder is due to a lack of blood supply to the legs, changes in the segments that occur in the bones, and muscle weakness, resulting in the legs experiencing limitations in movement. This is in line with Purwanti's, (2013) research, which explains that people with Diabetes mellitus experience relatively high peripheral neuropathy if they do not get good treatment.

### **Conclusion**

This descriptive study aims to describe the symptoms of sensory neuropathy and autonomic neuropathy experienced by patients with type 2 diabetes mellitus.

### **Acknowledgment**

The researcher would like to thank the Ministry of Education and Culture of the Republic of Indonesia for supporting and providing funding for the completion of this research. This is part of the PTUPT research, which received funding for two years. Thank you to all the respondents involved in this research.

### **References**

- Andersen, S. T., Witte, D. R., Dalsgaard, E. M., Andersen, H., Nawroth, P., Fleming, T., Jensen, T. M., Finnerup, N. B., Jensen, T. S., Lauritzen, T., Feldman, E. L., Callaghan, B. C., & Charles, M. (2018). Risk factors for incident diabetic polyneuropathy in a cohort with screen-detected type 2 diabetes followed for 13 years: Addition-Denmark. *Diabetes Care*, 41(5), 1068–1075. <https://doi.org/10.2337/dc17-2062>
- Azhar, F. H., Achmad, S., & Tursina, A. (2017). Hubungan Intensitas Nyeri dengan Kualitas Tidur Pada Pasien Neuropati Diabetik di Puskesmas Salam Bandung Fathichah Hafsyah Azhar 1 , Sadiyah Achmad 2 , Alya Tursina 3 1. *Prosiding Pendidikan Dokter*, 2, 258–267. <https://karyailmiah.unisba.ac.id/index.php/dokter/article/viewFile/8026/pdf>
- Bondor, C. I., Veresiu, I. A., Florea, B., Vinik, E. J., Vinik, A. I., & Gavan, N. A. (2016). Epidemiology of Diabetic Foot Ulcers and Amputations in Romania: Results of a Cross-Sectional Quality of Life Questionnaire Based Survey. *Journal of Diabetes Research*, 2016. <https://doi.org/10.1155/2016/5439521>
- Carmichael, J., Fadavi, H., Ishibashi, F., Shore, A. C., & Tavakoli, M. (2021). Advances in Screening, Early Diagnosis and Accurate Staging of Diabetic Neuropathy. *Front Endocrinol*, 26(12). <https://doi.org/10.3389/fendo.2021.671257>
- Freeman, R., Ralf, B., Bouhassira, D., Carbera, J., & Emir, B. (2014). Sensory profiles of patients with neuropathic pain based on the neuropathic pain symptoms and signs. *Pain Medicine*. <https://doi.org/10.1016/j.pain.2013.10.023>
- Halawa, M. R., Karawagh, A., Zeidan, A., Mahmoud, A.-E.-D. H., Sakr, M., & Hegazy, A. (2010). Prevalence of painful diabetic peripheral neuropathy among patients suffering from diabetes mellitus in Saudi Arabia. *Current Medical Research and Opinion*, 26(2), 337–343.

<https://doi.org/https://doi.org/10.1185/03007990903471940>

- Hwang, S., van Nooten, F., Wells, T., Ryan, A., Crawford, B., Evans, C., & English, M. (2018). Neuropathic pain: A patient-centred approach to measuring outcomes. *Health Expectations*, 21(4), 774–786. <https://doi.org/10.1111/hex.12673>
- Ministry of Health Republic of Indonesia. (2018). Laporan Riskesdas 2018 Kementerian Kesehatan Republik Indonesia. In *Laporan Nasional Riskesdas 2018* (Vol. 53, Issue 9, pp. 154–165). [http://www.yankes.kemkes.go.id/assets/downloads/PMK No. 57 Tahun 2013 tentang PTRM.pdf](http://www.yankes.kemkes.go.id/assets/downloads/PMK%20No.%2057%20Tahun%202013%20tentang%20PTRM.pdf)
- Pamungkas, R. A., Usman, A. M., Chamroonsawasdi, K., Khoirunisa, D., Hamzah, A. N., & Hidayat, R. (2022). Challenges of Neuropathy Screening for Preventing Diabetic Foot Ulcers: Perspectives of Public Health Nurses in Indonesia. *KnE Life Science*, 2022. <https://media.neliti.com/media/publications/512640-challenges-of-neuropathy-screening-for-p-ce2d19b9.pdf>
- Ponirakis, G., Elhadd, T., Chinnaiyan, S., Hamza, A. H., Sheik, S., Kalathingal, M. A., Anodiyil, M. S., Dabbous, Z., Siddique, M. A., Almuhammad, H., Petropoulos, I. N., Khan, A., AE Ashawesh, K., Dukhan, K. M., Mahfoud, Z. R., Zirie, M. A., Jayyousi, A., Murgatroyd, C., Slevin, M., & Malik, R. A. (2021). Prevalence and risk factors for diabetic neuropathy and painful diabetic neuropathy in primary and secondary healthcare in Qatar. *Journal of Diabetes Investigation*, 12(4), 592–600. <https://doi.org/10.1111/jdi.13388>
- Pop-Busui, R., Boulton, A. J. M., Feldman, E. L., Bril, V., Freeman, R., Malik, R. A., Sosenko, J. M., & Ziegler, D. (2017). Diabetic neuropathy: A position statement by the American diabetes association. *Diabetes Care*, 40(1), 136–154. <https://doi.org/10.2337/dc16-2042>
- Purwanti. (2013). Hubungan Faktor Risiko Neuropati dengan Kejadian Ulkus Kaki pada Pasien Diabetes Mellitus di RSUD Moewardi Surakarta. *Ilmiah Nasional Kesehatan*, 130–134. <https://publikasiilmiah.ums.ac.id/bitstream/handle/11617/3403/19.OKTI.pdf?sequence=1>
- Qureshi, M. S., Iqbal, M., Zahoor, S., Ali, J., & Javed, M. U. (2017). Ambulatory screening of diabetic neuropathy and predictors of its severity in outpatient settings. *Journal of Endocrinological Investigation*, 40(4), 425–430. <https://doi.org/10.1007/s40618-016-0581-y>
- Raskin, J., Pritchett, Y. L., Wang, F., D'Souza, D. N., Waninger, A. L., Iyengar, S., & Wernicke, J. F. (2005). A double-blind, randomized multicenter trial comparing duloxetine with placebo in the management of diabetic peripheral neuropathic pain. *Pain Medicine*, 6(5), 346–356. <https://doi.org/10.1111/j.1526-4637.2005.00061.x>
- Tavakoli, M., Yavuz, Di. G., Tahrani, A. A., Selvarajah, Di., Bowling, F. L., & Fadavi, H. (2017). Diabetic Neuropathy: Current Status and Future Prospects. *Journal of Diabetes Research*, 2017, 2–4. <https://doi.org/10.1155/2017/5825971>
- Tesfaye, S., Chaturvedi, N., Eaton, S. E. M., Ward, J. D., Manes, C., Ionescu-Tirgoviste, C., Witte, D. R., & Fuller, J. H. (2005). Vascular Risk Factors and Diabetic Neuropathy. *New England Journal of Medicine*, 352(4), 341–350. <https://doi.org/10.1056/nejmoa032782>
- Timar, B., Timar, R., Gaiță, L., Oancea, C., Levai, C., & Lungeanu, D. (2016). The impact of diabetic neuropathy on balance and on the risk of falls in patients with type 2 diabetes mellitus: A cross-sectional study. *PLoS ONE*, 11(4), 1–11. <https://doi.org/10.1371/journal.pone.0154654>
- Walter-Höliner, I., Barbarini, D. S., Lütschg, J., Blassnig-Ezeh, A., Zanier, U., Saely, C. H., & Simma, B. (2018). High Prevalence and Incidence of Diabetic Peripheral Neuropathy in Children and Adolescents With Type 1 Diabetes Mellitus: Results From a Five-Year Prospective Cohort Study. *Pediatric Neurology*, 80, 51–60. <https://doi.org/10.1016/j.pediatrneurol.2017.11.017>
- Zychowska, M., Rojewska, E., Przewlocka, B., & Mika, J. (2013). Mechanisms and pharmacology of diabetic neuropathy-experimental and clinical studies. *Pharmacological Reports*, 65(6), 1601–1610. [https://doi.org/10.1016/S1734-1140\(13\)71521-4](https://doi.org/10.1016/S1734-1140(13)71521-4)