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EARLY DETECTION OF DIABETIC FOOT PERIPHERAL NEUROPATHY WITH THE MICHIGAN NEUROPATHY SCREENING INSTRUMENT (MNSI): A SCOPING REVIEW

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***Keywords*:**
Michigan Neuropathy Screening Instrument, Diabetic Foot, Early Detection

ABSTRACT
Background: Neuropathy is a major cause of morbidity and mortality in type 1 and 2 diabetes worldwide. The development of neuropathy and its severity increases with increasing duration of DM and poor glycemic control. Early detection of neuropathy is essential to prevent worse disease complications. Objective: to identify a simple instrument MNSI in detecting peripheral neuropathy of diabetic foot. Methods: Scoping review protocol using 5 steps of Aksey and O'Malley Framework. Inclusion criteria were published in 2016-2023, full text, English language and discussed the use of MNSI in detecting peripheral neuropathy. This article used 4 databases (Pubmed, ProQuest, and ScienceDirect) with the keywords "Michigan screening instrument AND diabetic neuropathy AND early detection". Results: There were 10 articles that fit the inclusion criteria that mentioned that MNSI is a simple tool in detecting peripheral neuropathy in diabetic foot. Conclusion: MNSI is a reliable instrument, easy to do and can be used by doctors, nurses, and health workers involved in the treatment of patients with diabetes mellitus. .

INTRODUCTION

Diabetic foot neuropathy is one of the complications of diabetes mellitus (Kriatianto, H. 2023) and is the leading cause of morbidity and mortality of type 1 and 2 diabetes mellitus worldwide (Mete T., et al. 2013). More than 50% of people with diabetes mellitus experience neuropathy of about 21 million people with diabetes mellitus in America 60-70% experience various types of nerve damage and about 30% experience diabetic neuropathy at the age of 40 years and above (Mardastuti et al. 2016). Diabetic neuropathy is a precipitating factor for diabetic foot ulceration and non-traumatic lower limb amputation in most high-income countries (Selvarajah, 2019).

These neuropathic complications are higher in type 2 DM than in type 1 DM due to their insidious nature and late diagnosis (Singh, et al. 2014). The development of neuropathy and its severity increases with the increasing duration of DM and poor glycemic control (Nizal, et

al. 2015). Diabetic neuropathy manifests in, among other things foot ulcer (Shrestha, H. & Katwal, P. 2017), numbness, paresthesias, loss of coordination, burning, stabbing, pain, abnormal ankle reflexes , and others (Emanuel, et al. 2017).

Early detection of neuropathy is very important to prevent disease complications (Karki, et al. 2019). According to the American Diabetic Association (ADA), the diagnosis of neuropathy in clinical practice is made based on the presence of signs and symptoms of peripheral nervous system dysfunction in patients with diabetes mellitus, with 50% of people with diabetic neuropathy having no consistent neuropathy symptoms (Kaymaz, et al. 2020). A person is said to have neuropathy if abnormalities are found from clinical signs and symptoms, electrodiagnosis examination, temperature and vibration tests, and assessment of autonomic function (Mardastuti et al. 2016).

Diabetic neuropathy screening has been widely practiced with various methods and reliable tools. But often the tools used are difficult to use for non-experts and require expensive costs. Therefore, a simple Michigan Neuropathy Screening Instrument will be introduced to detect peripheral neuropathy of the diabetic foot.

METHOD

The method used is scoping review. The Scoping Review process uses the Arkey and O'Malley (2015) framework (Petters, M. et al., 2015). Consists of several stages, namely the first stage, formulating research questions using the PCC concept (population, concept, context) recommended by the Joanna Briggs Institute. Where the population is diabetes mellitus patients, the concept is the Michigan Neuropathy Screening Instrument, and the context is the symptoms of neuropathy in diabetic feet.

The second stage is a systematic search for relevant articles using 4 databases, namely Pubmed, Proquest, and ScienceDirect. The keywords used were "Michigan screening instrument AND diabetic neuropathy AND early detection". The third stage is the search strategy of scanning based on title, abstract and year. The author selected articles starting with screening articles from 4 databases based on titles and abstracts. Furthermore, the author conducted a thorough review of the articles that passed the screening stage to determine whether the selected articles were in accordance with the predetermined inclusion and exclusion criteria (Table 2).

The search strategy, relevant articles are presented in the form of a PRISMA diagram in Figure 1 below. Appropriate articles were presented in the form of a table containing author name, year of publication, research location, design and conclusion. The final stage is the data charting process, where themes for each article are documented in tables that relate to the research questions answered by the reviews in this scope. The results section below will further discuss the details found from the data charting with references. Furthermore, articles were selected based on the inclusion and exclusion criteria described in table 1

Table 1. Database Search Keywords

No	Database	Keywords
1	Pubmed	Michigan screening instrument AND neuropathy diabetic AND early detection
2	Proquest	Neuropathy diabetic OR diabetic mellitus AND early detection
3	ScienceDirect	Michigan Neuropathy screening instrument AND Diabetes Mellitus

Table 2. Inclusion and Exclusion Criteria

Selection Criteria	Inclusion Criteria	Exclusion Criteria
Language	English	Other than English
Year	2016-2023	< 2016
Subject	DM Type 1 & 2	Other than DM Type 1 & 2
Study type	Original research, Review article, Quantitative research	Thesis, dissertation, case study, news article
Topic	Michigan Neuropathy Screening Instrumen (MNSI)	Other than Michigan Neuropathy Screening Instrumen (MNSI)
Availability	Full Text	Partial Text

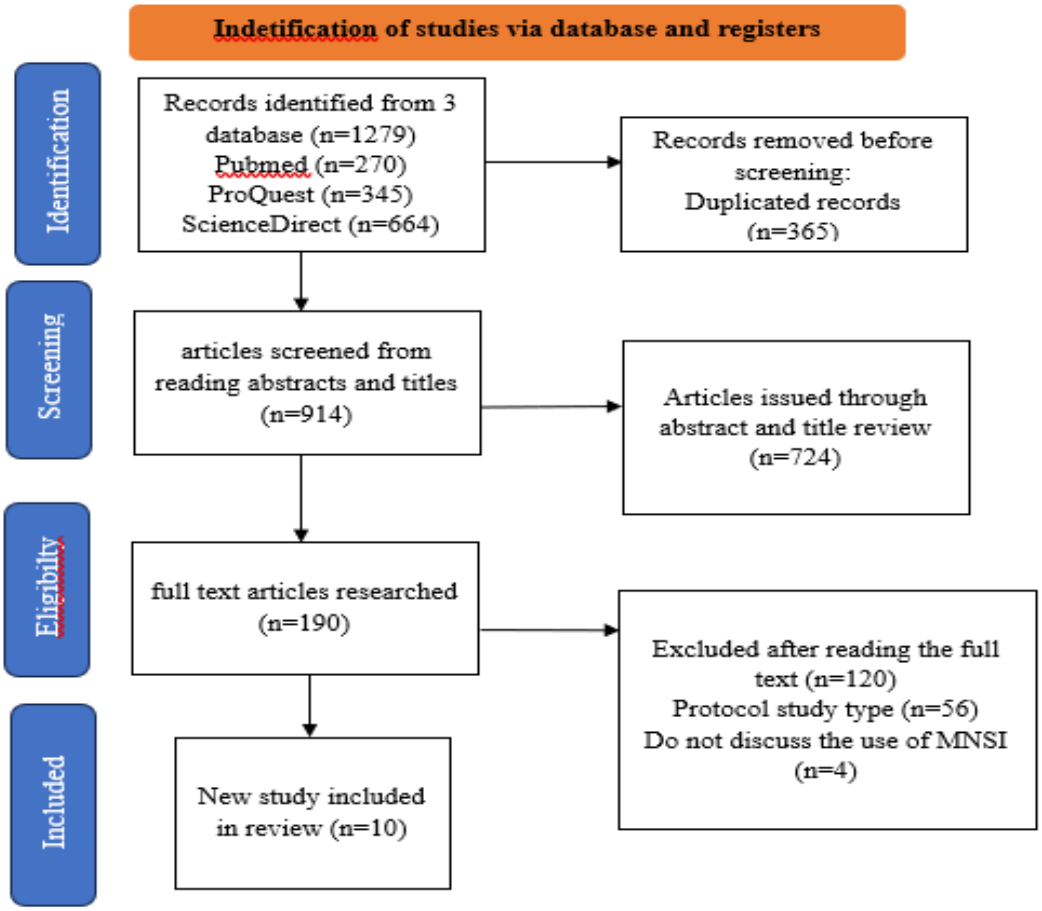

Figure 1. PRISMA diagram

RESULTS AND DISCUSSION

The results of searching articles on 3 databases obtained 1279 research articles, namely 270 articles from Pubmed, 345 articles from ProQuest, and 664 articles from ScienceDirect. The articles obtained were then subjected to a screening process resulting in 365 duplicate articles, 77 abstract articles and inappropriate titles. The remaining 190 full text articles were reviewed in full. As a result, 130 articles were excluded because they did not meet the inclusion criteria of the study. There were 10 articles selected according to the inclusion criteria and further summarized in table 3 below.

Table 3. Articles relevant to the use of MNSI in detecting diabetic foot peripheral neuropathy.

No	Author/Year	Results	Conclusion
1	Viswanathan *et al*., 2023	Cut-off point 2. AUC= 0.934, sensitivity 96.8%, specificity 85,7% dan accuracy 89.6%.	The Indian Version of MNSI is highly effective for screening neuropathy in patients with Type 2 DM. It is highly reliable and non-invasive and can be

			used routinely in diabetic foot examinations.
2	Aktar ReyhanïOğlu *et al.,* (2020)	Cut-off point MNSI-Q 3.5 sensitivity 75.5% dan spesifisity 68,1%. MNSI-E cut-off point 2.75%, sensitivity 87.5% and specificity 93.6%.	The Turkish version of MNSI is a highly valid and reliable method to evaluate peripheral neuropathy.
3	Kaymaz *et al*., (2020)	Cut-off point MNSI-A ≥3.0, sensitivity 97.6% and spesifisity 63,4%. PPV 72.7% & NPV 93.6% MNSI-E cut-off point ≥2.0, sensitivity 100% and specificity 97.6%. PPV 97.6 &NPV 100%.	Turkish version of MNSI is a reliable screening tool in detecting DPN in Turkish patients.
4	Barbosa *et al*., (2016)	Cut-off point MNSI-A ≥3, sensitivity 100% and spesifisity 64%. PPV 80% dan NPV 100% MNSI-E cut-off point ≥2.0, sensitivity 86% and specificity 61%. PPV 73% & NPV 79%.	The Portuguese version of MNSI is a very reliable tool in detecting peripheral neuropathy.
5	Sartor *et al*., (2018)	Excellent intra-rater reliability (ICC3,1=0.90), inter-rater reliability (ICC2,1=0.90) and within-subject reliability ICC3,1=0.80, excellent internal consistency (Cronbach's alpha>0.92)	The Brazilian version of MNSI can be used in DM patients in Brazil and this tool can be used in research as well as hospitals, health centers and others.
6	Tae Jung Oh *et al.,* (2022)	27.8% patient can be detected with MNSI	Screening using MNSI and SUDOSCAN can detect DPN and is acceptable for Korean patients with T2DM..
7	Mohammad *et al.*, (2019)	Correlation coefficient 0.87 (Reliability of the Arabic version of MNSI is good)	The Arabic version of the MNSI questionnaire is a reliable tool for screening neuropathy symptoms in patients with type 2 diabetes.

8	Matalqah *et al*., (2022)	The mean score of the MNSI questionnaire for all participants was 4.40 ± 3.00	Pharmacists can play a role in screening and counseling diabetic peripheral neuropathy using MNSI, which is an objective and non-invasive tool that can determine the level of damage and risk.
9	Zografou *et al*., (2020)	Positive results using MNSIQ and MNSIE in DPN patients were 111 and 119. Sensitivity 75%, specificity 92% and accuracy 83%.	MNSI accuracy is categorized as high or good in detecting DPN.
10	Pamungkas *et al*., (2023)	There were 59 respondents with low neuropathy risk, 40 respondents with moderate risk, and 1 respondent with severe risk.	Early detection to prevent neuropathy is very important with MNSI

The Michigan Neuropathy Screening Instrument (MNSI) is an easy-to-use screening tool to detect diabetic neuropathy. This instrument was first developed by the University of Michigan Department of Neurology with a sample of 56 patients and NCS as the gold standard (Feldman et al., 1994). It is designed for screening patients for diabetic neuropathy and can be used by internists, general practitioners, nurses, or other medical personnel involved in diabetes management. The MNSI promotes standardization of clinical evaluation and follow-up in hospitals, and has been used in several studies and the American Diabetes Association (Yang et al., 2018).

The MNSI consists of 2 parts. Part A (Quessioner) is a subjective assessment with 15 yes or no questions. Part B (Examination) is an objective assessment based on physical examination. Positive (pain, burning, and tingling) and negative (numbness) sensory symptoms, muscle cramps and weakness, leg ulcers, and amputation are asked in MNSI part A (Feldman et al., 1994; Aktar et al., 2020; Mete T., et al., 2013)."Yes" responses to questions 1, 2, 3, 5, 6, 8, 9, 11, 12, 14, and 15 received 1 point each. "No" responses to questions 7 and 13 received 1 point each. After completing the questionnaire, neurological evaluation was then performed on MNSI part B. On physical examination, a foot inspection was performed to assess for deformity, dry skin, callus, infection, and ulceration. Foot deformities include hallux valgus, joint subluxation, and Charcot joint. One point is awarded if any of the above signs are present. An additional 1 point is awarded if ulceration is present (Feldman et al., 1994; Aktar et al., 2020).

Vibration sensation was assessed with a 128 Hz tuning fork placed on the interfalangeal joint of the big toe. If the patient could not feel the vibration, 1 point was awarded. If the patient could feel the vibration, the patient was instructed to wait until the vibration disappeared and to signal immediately if the vibration was no longer felt. The tuning fork remains in its original place until the examiner cannot feel the vibration. The time difference when the vibration disappeared between the patient and the examiner was measured. If the

time difference was <10 seconds, the point awarded was 0. If the time difference was ≥10 seconds, the point awarded was 0.5 (Feldman et al., 1994; Aktar et al., 2020).

Monofilament examination is assessed with a 10gram monofilament. The patient's feet were relaxed and planted on the floor. The patient is instructed to close both eyes. The filament is placed on the dorsal toe, between the nail bed and the interfalangeal joint. The filament was pressed perpendicularly for a short time (<1 second) until the filament curved. The patient is asked to give a sign if they feel pressure. The examination is repeated up to 10 times. Point 1 is awarded if there is no correct response. 0.5 points are awarded if there are 1-7 correct responses. Point 0 is given if there are 8-10 correct responses (Feldman et al., 1994; Aktar et al., 2020).

Achilles reflex is assessed with a reflex hammer. The patient is in a seated position with the feet dangling. Mild dorsiflexion of the ankle is performed for optimal results. Percussion is performed directly on the Achilles tendon. Point 0 is given if there is a reflex without Jendrassik's maneuver. Point 0.5 is awarded if there is a reflex with the Jendrassik maneuver (redirection by interlocking the fingers of both hands). 1 point is given if no reflexes appear with the Jendrassik maneuver. (Feldman et al., 1994).

Aktar ReyhanïOğlu et al., (2020) in this case the Turkish version of MNSI, is a reliable and valid form with a cut-off value of 3.5 and a sensitivity of 75.5% and specificity of 68.1% for MNSI_Q and for MNS-E resulted in a sensitivity of 87.5% and specificity of 93.6% with a cut-off value of 2.75. In addition, the predictive ability of neuropathy with MNSI-E was found to be higher than MNSI-Q. An increase in MNSI-E score increased the risk of neuropathy by approximately 4.4-fold when compared to the MNSI-Q portion. Another study that supports these findings is by (Kaymaz et al., 2020), showing that the sensitivity value is 97.6% (MNS-Q) and 100% (MNSI-E); while specificity is 63.4% (MNSI-Q) and 97.6% (MNSI-E). These results indicate that MNSI-Q has good screening capabilities but is weak in diagnostics while MNSI-E has good screening and diagnostic capabilities.

Validation of MNSI to other languages has been done in many populations such as Iranian, Portuguese, Turkish, and Arabic. In the Iranian validation study, MNSI had a sensitivity of 65%, specificity of 83%, PPV of 80%, and NPV of 100% (Moghtaderi et al., 2006). In the Portuguese validation study, MNSI part A had 100% sensitivity, 64% specificity, 80% PPV, and 100% NPV. MNSI part B had a sensitivity of 86%, specificity of 61%, PPV of 73%, and NPV of 79% (Barbosa et al., 2016). In a Turkish validation study, MNSI part A had 97.6% sensitivity, 63.4% specificity, 72.7% PPV, and 96.3% NPV. MNSI part B had 100% sensitivity, 97.6% specificity, 97.6% PPV, and 100% NPV (Kaymaz et al., 2020). In an Arabic validation study, MNSI had a sensitivity of 95.9%, specificity of 62.5%, PPV of 75.8%, and NPV of 92.6% (Abuzinadah et al., 2021).

CONCLUSION

MNSI is a very reliable instrument, easy to perform and can be used by doctors, nurses, and health workers involved in the treatment of patients with diabetes mellitus. MNSI is able to screen and diagnose peripheral neuropathy well.

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