SYSTEMATIC / NARRATIVE REVIEW ARTICLE

The road less taken: A scoping review of the utilisation of hand assessments in individuals with diabetes mellitus

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ABSTRACT

Introduction: Diabetic peripheral neuropathy (DPN) is one of the most prevalent chronic complications of diabetes mellitus (DM) that can significantly result in disability and impaired quality of life. The DPN of the foot has been extensively studied in diabetes care. Nevertheless, the DPN of hand has been the road less taken in research and clinical practice. Thus, a scoping review was conducted to identify all available standardized hand assessments which have been used, developed, or tested in individuals with DM.

Materials and Methods: This scoping review was reported in alignment with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). Studies were identified through searches of five databases: Cochrane, Scopus, ProQuest, MEDLINE, and Web of Science (WoS).

Results: Of the 294 articles initially identified, 20 studies were included and analysed thematically after removing duplicates. The majority of these assessments measure body function and structure such as grip and pinch strength while the rest are measuring the activity and participation domain. Most of the hand assessments were performance-based measurements. It is suggestible to employ both types of assessments to obtain a comprehensive understanding of hand conditions in individuals with DM. While some validated hand assessments were identified, only the Duruöz Hand Index (DHI) has been validated as a reliable tool specifically for evaluating hand function in individuals with DM.

Conclusion: There is a need to evaluate the measurement properties of existing instruments for assessing the hand function in individuals with DM, or to develop hand assessments specifically for the DM population. This scoping review was forging a new path, by discovering diabetes care through the utilisation of hand assessments.

KEYWORDS:
Diabetes mellitus, hand assessment, hand function problems, International Classification of Functioning (ICF)

INTRODUCTION

Diabetes Mellitus (DM) is a pervasive metabolic disorder affecting millions of people globally, which requires the government to necessitate a multifaceted strategy for optimal management. It is estimated that by 2030, approximately 578 million people would be affected by DM, and this number is expected to increase by 51% (700 million) in 2045.[1] Diabetic peripheral neuropathy (DPN) is one of the most prevalent chronic complications of DM that can significantly result in disability and impaired quality of life.[2-5] With the progressive increase in the prevalence of DM, there would be a parallel increase in the occurrence and severity of complications as well. DPN can develop in both the lower and upper extremities, leading to physical function limitations across different body areas.[6-8] Hence, DPN could impact not only the feet but also the hands and fingers in terms of functional difficulties.

The DPN of the foot has been extensively studied in diabetes care. Comparatively, the DPN of the hand has been the road less taken in research and clinical practice. Despite the significant impact of hand neuropathy on functional ability and quality of life, it has been sometimes overlooked in diabetes care, both in research and clinical practice.[9-11] Standard approaches in diabetes care like blood glucose monitoring, medication, and lifestyle modifications are well-established as described in the literature.[12-14] Amidst neglect, the less explored frontier, namely the employment of hand assessments holds the promise of unveiling novel insights in the literature on DM. Exploring the DPN, particularly in the hands would lead to interventions to improve hand function, enhance patient education on DM, and minimize disability risks.[4,11,15,16] Early diagnosis and comprehensive management are essential for alleviating symptoms, preserving hand function, and preventing complications. Focusing on DPN in the hands would facilitate optimal functional outcomes and promote the overall quality of life for individuals living with DM.

The hand is the most active and important component of the upper extremity.[17] The specific scale in evaluating hand function is undetermined as it could not be assessed directly because of its structure and various functions. Thus, hand function is always illustrated to be assessed based on its components such as precision accuracy, grasp, pinch and

coordination. Hand function is also defined as the ability to perform daily activities using hands.[18,19] Previous literature mentioned the ability of the hand to perform precise movements, known as dexterity and hand strength which included both pinch and grip strength are part of the functional characteristics of the hand.[20,21] In the realm of hand rehabilitation, hand assessments are an essential component of our practice. They are fundamental to evaluation and intervention approaches in hand rehabilitation, serving as a crucial element in addressing hand-related issues in individuals.

As regards to DM, hand assessments could play a valuable role in the management of DM by identifying potential hand-related complications and developing optimal strategies for hand rehabilitation. DPN could lead to various issues like pain, reduced hand strength, impaired sensory and motor abilities, decreased tactile sensitivity, and compromised hand dexterity.[22,23] Additionally, a study highlighted substantial challenges faced by individuals suffering DPN, including struggles with activities of daily living such as fastening buttons, handling utensils, opening doors, sleeping problems, navigating stairs, walking, and efficiently performing work or household chores.[24] This emphasises the necessity of assessing the hand function as it directly impacts the overall quality of life and daily activities. As in the literature, hand assessments would be able to detect symptoms and assess hand strength, hand dexterity and other hand dysfunctions that would affect functional ability in individuals with DM.[7,8,25–28]

The International Classification of Functioning, Disability and Health (ICF) framework is internationally understood and applies to many health professions as ICF established a common language and framework in integrating knowledge of health conditions across disciplinary and geographic boundaries.[29] Undoubtedly, ICF might seem like a basic health classification but could be employed for a variety of purposes.[30] This framework provides a comprehensive way to understand the impact of health conditions on an individual's functioning and participation in society. Therefore, the consideration of the constructs being assessed was conducted with reference to the ICF.

Motivated by the important role played by hands in daily activities, which might be affected by DM and the fact for the lack of a review on hand assessment in this population, this review aimed to (1) identify all available standardized hand assessments which have been used, developed or tested in individuals with DM and (2) map the dimension/construct(s), types of the assessments, and (sub)scale(s) of the assessments involved using a framework focusing on human functioning.

MATERIALS AND METHODS
Study Design
This review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist.[31] The process involved five phases delineated as: 1) determining eligibility criteria, 2) identifying relevant literature, 3) studies selection, 4) data retrieval and charting, and 5) analysis and presentation of data.

Determining Eligibility Criteria
Scoping review employs a systematic approach to exploring the evidence related to the identified topic area.[31] This scoping review aimed to map out the relevant studies related to the utilisation of hand assessments in individuals with DM. Studies were included based on the following criteria: (1) peer-reviewed studies involved measurement instruments in assessing hand condition among individuals with DM, (2) studies were published between January 1, 2014, and March 31, 2023, (3) studies reported in English, and (4) the population focuses on individuals with DM type 2.

To avoid the impact of confounders, this study would focus on individuals with DM type 2 only as individuals with DM type 1 have distinct etiology and management. Studies were also excluded if they were focusing on conditions other than DM, applying different assessments other than hand assessments, grey literature published as editorial letters, dissertations, reviews, and conference abstracts, studies reporting non-standardised measures, and studies that are published before 2014.

Identifying Relevant Literature
Based on the eligibility criteria, the search for studies that meet the requirements began. Multiple electronic databases were searched namely Cochrane, Scopus, ProQuest, MEDLINE, and Web of Science (WoS). The keyword term for this topic was based on the medical subject heading (Mesh). The search keywords, terms and Boolean operators used in the database search strategy were; ("hand function* assessment" OR "hand assessment" OR "hand evaluation" OR "hand measurement" OR "hand therapy assessment" OR "hand dysfunction" OR "hand function" OR "hand disorder" OR "diabetic hand") AND ("diabetes mellitus" OR "type 2 diabetes mellitus" OR "diabetic" OR "non-insulin-dependent diabetes mellitus" OR "adult-onset diabetes" OR "Type-2 diabetes" OR "type 2 diabetes" OR "DM"). The identification process is shown in Figure 1. The identification of the relevant literature was carried out by two reviewers.

Study Selection
Two reviewers performed the selection of the studies. This stage includes a thorough analysis of the articles obtained from the five databases. Firstly, the articles were identified and retrieved from the selected databases, based on the search criteria and keywords used. Data extraction was considered to be thorough when the searches yielded no further articles beyond those newly identified ones through the searches. In all 294 articles were identified and retrieved from the databases (Figure 1). Then, a meticulous review was conducted by two reviewers to eliminate any articles that are deemed irrelevant or not applicable to the research topic. Following the removal of 5 duplicate articles, 289 articles were screened. Should a disagreement arise between the two reviewers, a third reviewer decided regarding the inclusion of the article. Initially, a title screening was conducted to quickly scan the article titles and determine their potential alignment with the research topic.

Next, a more comprehensive title and abstract screening were conducted to further evaluate the articles based on the abstracts. This allowed for a deeper assessment of the articles' suitability for the research, considering both the title and a summary of their content. Of the 51 articles, only 21 articles left for a thorough full-text screening. A total of 30 articles were excluded as the studies are not using the standardized assessment for hand conditions, focusing on other conditions other than DM, applying different assessments other than hand assessments, articles published as dissertations and the studies published before 2014. This involved a meticulous evaluation of the complete content of the articles, including the introduction, methods, results, and conclusion sections. The full-text screening enabled a detailed evaluation of the articles' relevance and alignment with the research objectives. After reviewing the full-text articles, 1 article was excluded as the study is focusing on other conditions other than DM. Eventually, this study encompassed a comprehensive selection of 20 articles, which were deliberately chosen for inclusion in this study.

Data Retrieval and Charting
The data retrieved from a comprehensive review of 20 articles were extracted and outlined and summarised in Table I according to the author, year, names of hand assessments involved in the study, dimension/ construct(s) to be assessed, type of hand assessment, (sub)scale(s) or the number of items and the dimension of hand assessment within the ICF framework.

Data Interpretation and Presentation
The articles were thoroughly reviewed by two reviewers, and the results were summarized in Table I by employing thematic analysis, based on themes associated with the contents of those hand assessments in identified articles. The findings were thoroughly analysed and deliberated in light of the components of ICF, and the approach employed in evaluating the hand function. The ICF uses a hierarchical coding system with three levels. The first level broadly categorizes into 'body functions and structures' and 'activities and participation', describing the impairments in body systems and structures, and covers limitations in an individual's ability to perform activities and participate in life situations. The second level provides more specific details within the first-level categories, while the third level offers even greater granularity. Nonetheless, this review exclusively relied on the first-level coding for the analysis as it provides high-level overview.

Ethics Approval and Informed Consent
Ethics approval was not required for this study.

RESULTS
There are two major themes derived from the qualitative review. One is the dimension of hand assessment within the ICF framework, and the other is the type of hand assessment involved. Each was discussed in detail below.

Dimension of Hand Assessment within ICF Framework
Across the included papers, a total of 20 hand assessments were identified. The hand assessments were grouped into two distinct categories (either 'body function and structure' or

'activity and participation'), depending on the published description of each assessment's intended scope of the evaluation. The most prevalent form of assessment is related to body function and structure domain within the ICF framework, as they focused on evaluating various physical parameters of hand function, such as grip strength, pinch strength, range of motion, and tactile sensation. The hand assessments that are extensively employed and mostly cited encompass the ones that evaluate grip and pinch strength,[7,8,37–39,15,16,26,32–36] which constitute a significant proportion of 60% of the utilised assessments, followed by Semmes-Weinstein monofilament (55%).[6,7,40,8,16,26,27,35,37–39] Included in the category of body function and structure assessments are a total of two evaluations that measure tactile acuity, namely static two-point discrimination (S2PD) (15%)[6,38,40] and moving two-point discrimination (M2PD) (10%).[6,40] As for the remaining assessments, each of them is utilised in a relatively small proportion of 5% among the overall assessments employed, namely goniometer, grip force control, pinch proprioception test and on-off vibration test.[8,35,37,39]

As for hand assessments related to the activity and participation domain within the ICF framework, the focus is on evaluating an individual's ability to engage in activities that require hand use and participation in everyday life tasks. Within this category, the most used assessment is Purdue Pegboard Test (40%), [7,11,16,22,32,33,38,40] followed by Michigan Hand Outcomes Questionnaire (MHQ) (20%),[11,22,32,40] Nine-hole peg test (20%),[8,15,32,35] the Duruöz Hand Index (DHI) (15%)[28,34,41] and Jebsen-Taylor Hand Function Test (JTHFT) (15%).[8,35,38] Other assessments namely the Patient Neurotoxicity Questionnaire (PNQ),[37] the Minnesota Manual Dexterity test,[15] the Keitel Functional Test (KFT),[42] The Arthritis Hand Function Test (AHFT),[42] and Disabilities of Arm, Shoulder and Hand Questionnaire (DASH)[3] were infrequently utilised in the studies conducted, with each assessment being employed in only 5% of the research, indicating a low prevalence in the literature. Table I provides information on the characteristics of the measurement instruments that were extracted and categorized based on the components framed within the ICF framework.

Type of Assessment
In the context of assessments, the term "type of assessment" refers to the methods or approaches used to measure or evaluate the intended constructs. It comprises numerous procedures for administering assessments, which might affect the validity, reliability, and fairness of the assessment outcomes. In this review, the hand assessments were categorized into two primary groups namely performance-based measurement and self-reported measurement. These two categories provide different approaches to assess hand function, with performance-based measurement focusing on objective measurements of capacity or actual/best performance, and self-reported measures capturing individuals' subjective perceptions of their hand function or actual performance. Most (80%) of the hand assessments used were classified as performance-based measurements, while only a limited number of four assessments (20%) were categorized as self-reported measurements that are the Disabilities of Arm, Shoulder Hand Questionnaire (DASH), Patient Neurotoxicity Questionnaire (PNQ), Michigan Hand

Table I: Articles summary

Hand Assessments Utilised in the Study	Author/s, Year	Dimension/ Construct(s)	Type of Assessment	(Sub)scale(s) and number of items	Dimension of Hand Assessment within ICF Framework
Grip and pinch strength Assessment of Hands [44]	Q. Zhang et al., 2021 [16] Y. Zhang et al., 2021 [7] Wani et al., 2019 [15] Gundmi et al., 2018 [32] Kamal et al., 2021 [8] Win et al., 2020 [37] Kender et al., 2022 [33] De Carvalho E Silva et al., 2014 [34] Lima et al., 2017 [35] Akpinar et al., 2017 [28] Ochoa et al., 2014 [26] Gorniak et al., 2014 [38]	Measurement of the maximum force that an individual can exert with their hands during grip and pinch tasks	Performance-based	Measures related to grip and pinch strength	Body function and structure
Pinch Strength Assessment of Hands [44]	Yahya et al., 2019 [39]	Measurement of the maximum force force that an individual can exert with their hands during pinch tasks	Performance-based	measures related to pinch strength	Body Function and Structure
Grip force control assessment	Lima et al., 2017 [35]	Measurement of hand grip force control during object manipulation	Performance-based	Measures related to grip and pinch strength	Body function and structure
Pinch proprioception testing [39]	Yahya et al., 2019 [39]	Measurement of the pinch proprioception using a modified goniometer with its fulcrum fixed on top of a small cardboard.	Performance-based	Single measurement of pinch proprioception	Body Function and Structure
Pinch-Holding-Up Activity (PHUA) Test [56]	Kuo et al., 2019 [40] Chiu et al.. 2014 [6]	Measurement of the ability of an individual to hold an object between the thumb and index finger and lift it up to a target height.	Performance-based	Single measurement of hand function to determine the features of sensorimotor control in the hand	Body function and structure
Semmes-Weinstein monofilament (SWM) [57]	Kuo et al., 2019 [40] Gorniak et al., 2014 [38] Q. Zhang et al., 2021 [16] Y. Zhang et al., 2021 [7] Chiu et al., 2014 [6] Ochoa et al., 2014 [26] Lima et al., 2017 [35] Gorniak et al., 2020 [27] Kamal et al., 2021 [8] Yahya et al., 2019 [39] Win et al., 2020 [37]	Measurement of the touch threshold test in the hands.	Performance-based	Single measurement of the touch-pressure threshold test with 20 nylon filaments with of varied thickness	Body function and structure
on–off vibration tests (128 Hz tuning fork)	Win et al., 2020 [37]	Measurement of vibratory sensation as rapid screening for diabetic neuropathy	Performance-based	Single measurement of individual's ability to perceive vibration at 128 Hz.	Body function and structure
Static two-point discrimination (S2PD)	Chiu et al., 2014 [6] Lima et al., 2017 [35] Kuo et al., 2019 [40]	Measure of tactile spatial acuity, or the ability to distinguish two closely spaced points applied to the skin at the same time	Performance-based	Single measurement of tactile spatial acuity	Body Function and Structure

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Table I: Articles summary

Hand Assessments Utilised in the Study	Author/s, Year	Dimension/ Construct(s)	Type of Assessment	(Sub)scale(s) and number of items	Dimension of Hand Assessment within ICF Framework
Moving two-point discrimination (M2PD)	Chiu et al., 2014[6] Kuo et al., 2019[40]	Measure of tactile spatial acuity, similar to static two-point discrimination (S2PD), but with the added dimension of movement	Performance-based	Single measurement of tactile spatial acuity	Body Function and Structure
12" plastic goniometer	Kamal et al., 2021[8]	Measurement of total active motion of the wrist	Performance-based	single measurement of range of motion	Body function and structure
Purdue Pegboard Test[58]	Kuo et al., 2019[40] Gorniak et al., 2014[38] Q. Zhang et al., 2021[16] Y. Zhang et al., 2021[7] Yang et al., 2015[11] Yang et al., 2018[22] Gundmi et al., 2018[32] Kender et al., 2022[33] Yang et al., 2018[22]	Measurement of hand dexterity	Performance-based	Four subtests (right hand left hand, both hands and assembly), each of which measures a different aspect of manual dexterity. The four subtests include tasks that involve using the right hand (RH), left hand (LH), both hands (BH), and assembly.	Activity and participation
Nine-Hole Peg Test[59]	Lima et al., 2017[35] Wani et al., 2019[15] Gundmi et al., 2018[32] Kamal et al., 2021[8]	Measurement of hand dexterity	Performance-based	Two subtests: measurement of the time taken for a subject to place and remove nine pegs in a hole on pegboard.	Activity and participation
Minnesota Manual Dexterity test[60]	Wani et al., 2019[15]	Measurement of individual's ability to perform simple, rapid eye-hand coordination and arm-hand dexterity (gross motor skills)	Performance-based	Five subtests: Placing test, Turning test, Displacing test, One-hand Turning and Placing test, and the Two-hand Turning and Placing test	Activity and participation
Jebsen-Taylor Hand Function Test (JTHF)[61]	Gorniak et al., 2014 38 Lima et al., 2017 35 Kamal et al., 20218	Measurement of hand function using simulated ADL, including speed, dexterity, and coordination	Performance-based	Seven subtests/activities, which assess different functional activities of the hand namely writing a twenty-four letter sen- tence, card turning ability, lifting small common objects, stacking checkers, simulated feeding, lifting large light objects (e.g., empty cans), and lifting large heavy objects (e.g., lifting cans of approximately 0.45 kg).	Activity and participation

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Table I: Articles summary

| Hand Assessments Utilised in the Study	Author/s, Year	Dimension/ Construct(s)	Type of Assessment	(Sub)scale(s) and number of items	Dimension of Hand Assessment within ICF Framework
Patient Neurotoxicity Questionnaire (PNQ) [62]	Win et al., 2020 [37]	Measurement of the presence of difficulties in ADL-related areas	Self-reported	3 subscales that identify the incidence and severity of sensory and motor disturbances and the types of activities of daily living, which need to be ticked if they have difficulties	Activity and participation
Keitel Functional Test (KFT) [63]	Poole et al., 2016 [42]	Measurement of functional performance	Performance-based	24 items assessing joint range of motion and muscular activity. 3 groups: hands and wrists (9 items), shoulders (2 items) and lower limbs (13 items).	Activity and participation
The Arthritis Hand Function Test (AHFT) [64]	Poole et al., 2016 [42]	Measurement functional status of the hand	Performance-based	11 tasks assess hand strength, dexterity, applied dexterity, and applied strength while performing activities associated with self-care, work, and leisure.	Activity and participation
Disabilities of Arm, Shoulder and Hand Questionnaire (DASH) [65]	Joshi et al., 2021 [3]	Measurement of physical function and symptoms in patients with any or several musculoskeletal disorders of the upper limb	Self-reported	30 items that assess upper extremity physical function and symptoms	Activity and participation
Michigan Hand Outcomes Questionnaire (MHQ) [66,67]	Kuo et al., 2019 [40] Yang et al., 2015 [11] Gundmi et al., 2018 [32] Yang et al., 2018 [22]	Measurement of patients' perceptions of functional hand performance	Self-reported	37 items questionnaire, which are grouped into six subscales (overall hand functioning, activities of daily living, pain, work performance, aesthetics and patient satisfaction with hand function)	Activity and participation
The Duruöz Hand Index (DHI) [51,68]	De Carvalho E Silva et al., 2014 [34] Poole et al., 2016 [42] Akpinar et al., 2017 [28]	Measurement of the functional status of the hand in patients with hand and wrist disorders.	Self-reported	18 items that assess various hand functions, including hand ability in the kitchen, during dressing, while doing personal hygiene, office tasks, and other general items.	Activity and participation
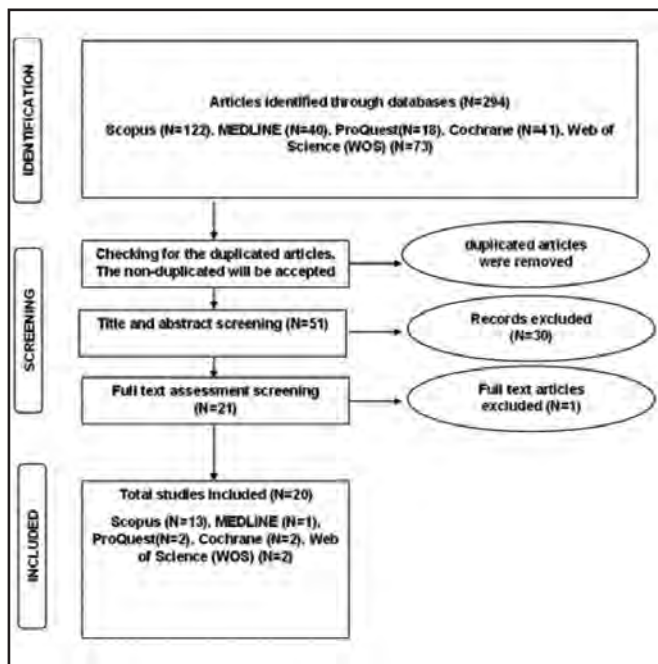
Fig. 1: The search processes

Outcomes Questionnaire (MHQ), and The Duruöz Hand Index (DHI).

DISCUSSION

This scoping review sought to comprehensively explore and synthesize the available hand assessment that have been used, tested, or developed for individuals with DM, providing a novel contribution to the existing literature in this area of study. This review is akin to navigating uncharted territory by exploring diabetes care through hand assessments as the findings of this study are based on fairly limited literature. The findings could be used to identify potential research gaps or areas of hand assessment in individuals with DM for further development. In an effort to ensure that the study reflects the most current research, the researchers have decided to exclusively focus on studies conducted within the past 10 years. This aligns with the concept of research field maturity highlighted in previous literature, as it facilitates a comprehensive evaluation due to the ample availability of a significant number of published studies.[43]

In this review study, the ICF framework was used to categorize the utilisation of hand assessments as it provides a conceptual clarity which would enhance the quality and comparability of hand assessments used. The hand assessment categorization was done by aligning them with the relevant domains within the ICF framework, considering the published descriptions that specify the intended purpose of each hand assessment. The two domains within the ICF framework involved were 'body function and structure' and 'activity and participation'. These two domains within the ICF framework could be a guiding principle when determining appropriate treatment approaches.

This study sheds light on the fact that hand assessments in patients with DM were dominated by the body function and structure domain than the activity and participation domain. This is unsurprising, as measures of body functions and structures domain have been extensively validated for their psychometric properties and are widely integrated into clinical practice.[44,45] As a systemic condition, DM could affect numerous physiological functions and structures within the body. This is exemplified in a study that illustrated the inclusion of a wide range of body-function categories in both the Comprehensive ICF Core Set and the Brief ICF Core Set for DM.[46] The Comprehensive ICF Core Set for DM encompassed a total of 99 categories, comprising 85 at the second level and 14 at the third level. This classification encompassed 36 categories related to body functions, 16 associated with body structures, and 18 concerning activities and participation. As for the Brief ICF Core Set, it comprised a total of 33 second-level categories, with 12 addressing body functions, 6 focusing on body structures, and 5 relating to activities and participation.[46]

More than half research studies (60%) incorporated the evaluation of the activity and participation domain alongside the evaluation of the body functions and structures domain. This integrated approach could view a holistic picture of hand function, encompassing not only the physiological aspects (body functions and structures) but also the functional aspects (activity and participation) in a more comprehensive manner. In some cases, even minor impairments in hand can result in significant limitations in a person's ability to perform activities or participate in various aspects of life, such as self-care, work, and leisure activities. These limitations may arise from the cumulative effects of multiple minor impairments that collectively hinder an individual's functional abilities. In contrast, major impairments of body functions, such as severe muscle weakness or sensory loss, may not always directly translate into limitations in activities or participation, as individuals may adapt or compensate using alternative strategies. Yang et al[11] mentioned that diabetic patients commonly find ways to adapt their hand deficits in performing their daily activities. Hence, it is essential to assess not only body functions and structures, but also activities and participation, to gain a comprehensive understanding of how hand conditions would influence an individual with diabetic overall functional status and engagement in meaningful activities. Other than that, healthcare providers would be able to better tailor interventions and treatment plans to address the specific challenges and needs of the individual.

Throughout reviewed studies, grip and pinch strength evaluations are commonly utilised for assessing body functions and structures domain of the hand. Grip and pinch strength are assumed as key indicators of hand function that provide insight into the overall health and capabilities of the hand. The pinch gauge achieved the highest accuracy at ±1%, and reliability (ICC=0.98) while the Jamar dynamometer was found to be highly reliable (ICC = 0.98) and valid (ICC= 0.99) (42,44). Even so, there is a lack of consistency and variability observed in the findings of various studies when it comes to the association between DM and hand strength.[32] Different research studies have reported

conflicting results, with some indicating a correlation between DM and hand strength, while others show no significant association. [36,47–49] Also included in the body functions and structures domain are assessments of sensory function, tactile acuity, range of motion, and proprioceptive function. Given that DM could cause nerve damage and result in diminished sensory perception, tactile sensation, proprioceptive function, and limited joint mobility, it was expected for the researchers to evaluate these components. [8,32,47,50]

To achieve a comprehensive understanding of hand condition, it is essential to not solely focus on improving body functions and structures but also to thoroughly evaluate and address issues related to hand performance skills. Studies have revealed that DM would affect activities of daily living. [4,49] Thus, it was predicted that the studies would assess the activity and participation domain as well. This review suggests that a variety of hand assessments have been used in individuals with DM. Purdue Pegboard Test (PPT) and Nine-Hole Peg Test are using pegboard test in evaluating the coordination of the hands while the Michigan Hand Outcome Questionnaire (MHQ), Duruöz Hand Index (DHI), Disabilities of Arm, Shoulder and Hand Questionnaire (DASH), and Patient Neurotoxicity Questionnaire (PNQ) would assess general performance skills in ADL and/or participation.

As for Keitel Functional Test (KFT), Minnesota Manual Dexterity test, and Jebsen-Taylor Hand Function Test (JTHF); these assessments would evaluate fine motor skills and the functional capacity of the arm. This review revealed that hand assessments were used to evaluate different aspects of activities. Considering the complexity of hand function and the wide range of variables that can impact it, there is currently no consensus on a single assessment method that can be recommended to be the most effective hand function assessment. Nevertheless, among the various assessments used, only the Duruöz Hand Index (DHI) has been validated as a reliable tool specifically for evaluating hand function in individuals with DM. [51]

Throughout the reviewed studies, the researchers utilised two different approaches in evaluating the hand condition of individuals with DM, namely self-reported measurement and performance-based measurement. Most of the research conducted on evaluating hand condition in individuals with DM has primarily employed performance-based measurement as the main approach for evaluation. Performance-based measurement involves objective measurements of the physical capabilities and function of the hand. The individuals need to demonstrate their skills or performance through tasks or activities assigned to them. This could include tests or assessments that measure grip strength, range of motion, tactile sensitivity, dexterity, or other physical parameters related to hand health. Performance-based measurement provides a more objective and quantitative evaluation of the actual physical abilities and functional limitations of the hand in individuals with DM. [28,34]

On the other hand, the self-reported measurement would allow individuals to provide their own appraisal of their feelings or abilities related to their condition. This could include questionnaires, interviews, or surveys that asked individuals to report on their hand-related symptoms, functional limitations, pain, discomfort, or overall perception of their hand health. Self-reported measurement could provide insights into how individuals perceive their own hand condition and how it impacts their daily activities and quality of life. [52,53]

Generally, both self-reported and performance-based measurement approaches have pros and cons. Despite that, the assessment of hand condition in individuals with DM might be differently represented when using self-reported or performance-based measures, and this variation may be influenced by various patient-related factors. [25] Factors such as age, gender, the severity of DM, the presence of comorbidities, and individual perceptions of symptoms and function can impact the outcomes of self-reported and performance-based measures.

According to Poole et al. [10] the self-reported measurement could cover a wider range of skills than performance-based measurement. This is in line with a study by Coman et al. [54] that mentioned self-reported measurement has been demonstrated to be reliable as performance-based measurement. Literature also suggested that measuring functional limitations through self-reported measurement or performance-based measurement is likely to yield similar results, implying that both methods are potentially valid and reliable measures of function. [54] Nonetheless, the accuracy of self-reported measurement might be questionable as patients are more likely to report being capable of performing a task despite actually being unable to do so. [25,55] Generally, performance-based measurement is designed to assess the capability to perform a specific task within the construct of functional limitation, but it might not fully capture the real-life context of hand use in everyday activities like self-reported measurement. Thus, employing both self-reported and performance-based measurements would be advantageous, as they allow the practitioners to obtain a comprehensive understanding of hand conditions in individuals with DM.

LIMITATIONS
Though this scoping review was planned and conducted in accordance with applicable criteria by Tricco et al., [31] some limitations must be highlighted. It did not attempt to evaluate the quality of the included hand assessments as per scoping review methodology. Yet the articles included were published in peer-reviewed journals; opinion pieces, narrative reviews, non-English articles, and grey literature were eliminated. Future studies should assess the psychometric qualities of the hand assessments involved in individuals with DM. The search was confined to five databases (Cochrane, Scopus, Web of Science (WoS), ProQuest and Medline) only. While these five databases are commonly acknowledged as the primary repositories for indexing healthcare publications, it is possible that articles

related to hand assessments in DM may have been indexed in other databases, but unintentionally missed in the search process. It is worth noting that there may be also a limitation as articles in languages other than English were not included.

CONCLUSION

The objective of the scoping review was to identify relevant literature utilising hand assessments for evaluating hand conditions in individuals with DM. Among the 20 hand assessments identified, most measure body function and structure such as grip and pinch strength, while a smaller proportion of the assessments measure the activity and participation domain. Only the Duruöz Hand Index (DHI) has been validated as a reliable tool specifically for assessing hand function in individuals with DM. There is a need to evaluate the measurement properties of the other identified instruments for individuals with DM. Additionally, this review recognized two main types of assessments: self-reported measurement and performance-based measurement. Both assessments have the potential to provide valuable information about hand function but might measure different aspects of hand function. Performance-based measurement is more commonly used; however, self-reported measurement offers advantages such as ease of use, efficiency, accessibility, and minimal resource requirements. Currently, there is a lack of performance-based measurement and self-reported measurement tools for hand function specifically designed for individuals with DM. However, the Duruöz Hand Index has been validated as a practical and efficient self-reported measurement tool that can accurately assess hand dysfunction in diabetic patients. Hence, this reflects that self-reported measurement would be a good way to measure how well individuals with DM could use their hands.

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