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Research

Inter-rater reliability of hand muscle strength, dexterity, function, joint mobility and sensory threshold assessments in individuals with type 2 Diabetes Mellitus in central part of Kerala, India

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Abstract

Background: Type 2 Diabetes Mellitus (T2DM) often leads to musculoskeletal complications affecting hand strength, dexterity, and function. Reliable assessment tools are essential for early detection and management of hand dysfunction, but inter-rater reliability in this population remains underexplored.
Aim: To determine the inter-rater reliability of hand muscle strength, dexterity, function, joint mobility, and sensory threshold assessments in individuals with T2DM in central Kerala, India.
Methods: Eighteen adults with T2DM were evaluated by two physiotherapists using standardized tools including hand-held dynamometer, pinch gauge, nine-hole peg test, box and block test, Indian-Cochin Hand Function Scale, goniometry, and Semmes Weinstein monofilaments. Inter-rater reliability was analyzed using intra-class correlation coefficients (ICC).
Results: Inter-rater ICC values ranged from 0.71 to 0.99, indicating moderate to excellent reliability across all hand assessments. The highest reliability was observed for sensory threshold (ICC = 0.99) and hand function score (ICC = 0.95).
Conclusion: The study confirms moderate to excellent inter-rater reliability of hand assessment tools in individuals with T2DM. These findings support their clinical use in physiotherapy for early detection and management of diabetic hand dysfunction.

Keywords: Diabetes Mellitus, T2DM, Hand strength, Range of motion, Sensation, Dexterity, Joint mobility.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) represents a global health care crisis, with an estimated 589 million adults currently affected with diabetes across the globe, which is expected to escalate to 853 million by 2015.[1] Over 80 % of individuals with DM reside in low and middle income countries, where limited access to healthcare exacerbates disease outcomes and complications.[2] In developing economies like India, the prevalence and incidence rate of DM is alarming and approximately 57% of individuals remain undiagnosed.[3,4] Kerala, being a small state in the southern part of India, the health indicators are highly comparable with developed countries. However, studies have reported an epidemic trend of T2DM in Kerala with high incidence of prediabetes.[4,5] The reasons could be rapid urbanization, unhealthy lifestyles, obesity and genetic predispositions.[3]

T2DM is associated with involvement of various systems of the body including musculoskeletal system, which can contribute to reduced mobility, functional limitations and ultimately affecting activities of daily living (ADL).[6] Diabetic hand syndrome encompasses conditions like limited joint mobility which manifests as stiffness and restricted hand function in T2DM. Epidemiological data indicate that hand disorders are highly prevalent in individuals with T2DM with risk factors including female gender, advanced age, disease duration, retinopathy and hypertension.[7,8] Researches have demonstrated significantly reduced grip and pinch strength in individuals with T2DM compared to non-diabetic controls.[6,9]

Hand function is integral to ADL activities, including fine motor skills for grasping, manipulating objects and self-care tasks.[10] Accurate evaluation of hand function is essential for early detection, monitoring progression and implementing targeted rehabilitation programs in T2DM. The hand assessment includes hand muscle grip strength, pinch strength, fine dexterity, gross dexterity, hand function evaluation, hand joint mobility and sensory evaluation in T2DM.[6,11]

Even though, standardized measurement tools are available to quantify these impairments, their utility hinges on their reliability, particularly inter-rater reliability, which measures the consistency of scores across different evaluators.[12] High inter-rater reliability ensures reproducible clinical decisions and enhances the validity of outcome measures. Despite the established burden of hand impairments in T2DM, significant gaps exist in the literature regarding the inter-rater reliability of hand assessments in this population. This lacuna is particularly evident in Kerala population, which hampers the integration of hand assessments into routine diabetic care management protocols.

Addressing these gaps, current study investigates the inter-rater reliability of selected hand assessments hand grip strength using hand held dynamometer, pinch strength using pinch gauge, fine hand dexterity using nine-hole pegboard test, gross dexterity using box and block test, hand function using Indian-Cochin hand function scale, hand joint mobility using composite finger range of motion and goniometry and sensory threshold using Semmes Weinstein monofilaments at central part of Kerala.

MATERIALS AND METHODS

This study employed a cross-sectional design to evaluate the inter-rater reliability of selected hand assessment tools in individuals with T2DM. All assessments were performed on the same day to minimize temporal variability, with raters blinded to each other's results to reduce bias. Participants were recruited from the community medical camp conducted at Ernakulam. Inclusion criteria encompassed individuals clinically diagnosed with T2DM by a medical practitioner within the age group of 50 to 70 years, more than 10 years of disease duration, who demonstrated positive prayer sign or table top sign and self-reported decline in hand function. Exclusion criteria included acute hand injuries, recent upper limb surgery within past six months, rheumatological or degenerative conditions affecting upper limb, neurological or medical disorders affecting upper extremity and severe cognitive impairment.

Eighteen participants were selected based on the inclusion and exclusion criteria in June and July 2024 including both genders and varying socio-economic backgrounds. Informed written consent was obtained from all participants and was conducted in compliance with the Declaration of Helsinki.

Two qualified physiotherapists with more than two years of experience as clinical therapists were the raters. Both therapists underwent a training on how to conduct the assessment and practiced on two mock participants to ensure procedural conformity. Training was intended to ensure consistent patient positioning, verbal instructions and data recording to minimize inter-rater variability. Raters were blinded to participant's clinical history and each other's scores with evaluations conducted in two rooms.

Assessments were conducted on the dominant hand which was decided by patient's self-report on handedness. A five-minute rest period was granted to avoid fatigue of the participants and learning effects and a fifteen minutes gap was provided between the assessments of raters to allow recovery. Standardized verbal instructions were provided to the participants and they were instructed to put maximum effort during the assessment.

Hand grip strength was assessed with a calibrated KERN hand held dynamometer. Participants sat with shoulder adducted, elbow flexed at 90^0, forearm and wrist in neutral position.[13,14] Three maximal voluntary contractions were performed and the average was recorded.[14,15] Pinch strength was assessed with hydraulic pinch gauge evaluating lateral pinch or key pinch on dominant hand. Participants maintained same upper limb position as for grip strength and average of three measurements was documented.[16]

Fine hand dexterity was assessed with nine-hole peg test, a timed task measuring finger coordination and precision. Participants placed nine pegs into a board and put back into the case with the dominant hand. The time to complete the task in seconds was recorded.[17] Gross dexterity was assessed via box and block test which quantify the number small cubes of 2.5 cm transferred from one compartment to another in 60 seconds. Participants sat with the box in the midline and a 15 seconds practice trial was granted.[18,19]

Indian- Cochin Hand Function Scale (ICHFS) measured self-reported hand function on an 18-item questionnaire evaluating daily activities on a Likert scale, with higher scores indicating more disability. The scale was administered in Malayalam to adjust literacy variations.[20,21] Finger flexion range of motion of index finger was assessed as the distance from the fingertip of index finger to the ruler kept perpendicular at distal palmar crease and measured in millimetres (mm).[22,23] Wrist joint flexion and extension were evaluated with standard goniometer which is a reliable and valid tool to assess range of motion.[24] Protective sensation was assessed with Semmes Weinstein monofilaments, applying filaments of various forces perpendicularly to five different sites in the palm. The threshold was the smallest filament detected at the sites.[25,26] All data were recorded in a standardized document. Data were analysed using SPSS version 21 and descriptive statistics and inter-rater reliability was computed.

RESULTS

A total of eighteen patients withT2DM were recruited from community medical camp in central part of Kerala which included ten males and eight females. The mean age of the sample was 58.39 (±6.72) and all individuals were right hand dominant based on the screening with Edinburgh handedness inventory. The mean body mass index was 24.71 (±3.05), the average duration of T2DM was 14.72 (±3.99) and the glycated hemoglobin levels (HbA1c) averaged 8 (±0.94). Comorbidities included hypertension in nine individuals, hyperlipidemia in six subjects and cardiac disease in one person. Assessments were conducted by two qualified therapists who were blinded to each other's result. Inter-rater reliability was analyzed using intra class correlation coefficients (ICC), with ICC values interpreted as poor (<0.50), moderate (0.50 -0.75), good (0.75-0.90) or excellent (>0.90).

The hand grip strength assessed with hand held dynamometer measured in kilograms in dominant hand recorded mean strength 12.48 (±2.08) by rater 1 and 13.21 (±2.89) by rater 2. The ICC was 0.89, CI 95%, SE 0.04, indicating good inter-rater reliability. The lateral pinch strength measured with pinch gauge in kilograms reported mean strength 4.65 (±1.06) by rater 1 and 5.06 (±1.65) by rater 2 in dominant hand. The ICC was 0.85, CI 95%, SE 0.07, indicating good inter-rater reliability.

Table 1: Inter-rater reliability of hand assessments in individuals with T2DM

Assessment	Rater 1 Mean (SD)	Rater 2 Mean (SD)	ICC	SE
Hand Muscle Strength	12.48 (±2.08)	13.21 (±2.89	0.89	0.04
Lateral Pinch Strength	4.65 (±1.06)	5.06 (±1.65)	0.85	0.07
Fine Dexterity	28.94 (±3.92)	30.94 ((±5.43)	0.71	0.11
Gross Dexterity	56.72 (±5.44)	57.89 (±7.09)	0.89	0.05
Hand Function ICHFS	22.83 (±2.62)	23 (±2.83)	0.95	0.04
Composite Finger Flexion	24.78 (±3)	25.67 (±3.93)	0.87	0.09
Thumb Opposition ROM	14.89 (±2.54)	15.5 (±3.05)	0.89	0.06
Wrist Flexion ROM	65.39 (±3.03)	66.17 (± 3.71)	0.89	0.06
Wrist Extension ROM	49.89 (±3.79)	51 (±5.25)	0.93	0.03
Sensory Score	0.29 (±0.46)	0.27 (±0.46)	0.99	0.02

In summary, this study demonstrated moderate or good or excellent reliability (ICCs from 0.71 to 0.99) for hand assessments of hand grip strength, pinch strength, fine dexterity, gross dexterity, hand function scale, composite finger flexion, thumb opposition, wrist joint flexion, wrist joint extension and sensory threshold score in individuals with T2DM.

DISCUSSIONS

The present study evaluated inter-rater reliability of selected hand assessments in individuals with T2DM from central part of Kerala, India. The findings revealed moderate to excellent inter-rater reliability across all measures. These results underscore the robustness of standardized assessment tools to assess hand impairments and dysfunction.

Hand muscle strength measured with hand held dynamometer revealed good reliability aligning with prior investigations in T2DM. Studies have reported high inter-rater reliability for dynamometry in diabetic cohorts.[27,28] The results of reliability of lateral pinch strength measured with pinch gauge demonstrated good reliability which is similar to other study results.[16,29] Diminished pinch strength could be the result of peripheral neuropathy and microvascular changes which emphasizes need for precise assessment to detect early functional decline.[30]

The fine dexterity demonstrated moderate reliability and gross dexterity reported good reliability which aligns with the findings of other studies.[31,32] These dexterity tests are relevant in T2DM, where hand impairments can affect ADLs. The I-CHFS which is culturally adapted to Indian contexts displayed excellent reliability.[20,21] Reliability studies of CHFS in other pathologies affirm its strength, supporting the findings of the present study.[33] The finger, thumb and wrist joint mobility expressed good reliability aligning with other studies.[34,35]

CONCLUSION

Finally, these reliable assessments enable early detection of hand dysfunction in T2DM, facilitating physiotherapy interventions and targeted exercises to reduce disability and improve quality of life. Limitations include modest sample size and non-randomized recruitment of samples. Future research should explore the intra-rater reliability and larger multi centre evaluations including subjects from different socio-cultural backgrounds. In conclusion, this study affirms the inter-rater reliability of hand assessments in T2DM. Early detection of hand dysfunction is significant in prevention of decline in ADLs and quality of life of individuals with T2DM.

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