International Journal of Health Sciences and Research
[Indexed, Peer-Reviewed Journal]
Volume 15; Issue: 4; April 2025
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Effect of Diabetes Duration on Dominant and Non-Dominant Hand Dexterity in Middle-Aged Adults: A Cross-Sectional Study

Sadhana Dharmraj Chougule[1], Bhagyashree Kamble[2], Medha Deo[3]

[1]Intern at Terna Physiotherapy College Navi Mumbai
[2]Assistant Professor of Terna Physiotherapy College, Navi Mumbai
[3]Principal and Professor of Terna Physiotherapy College, Navi Mumbai

Corresponding Author: Bhagyashree Kamble

DOI: https://doi.org/10.52403/ijhsr.20250407

ABSTRACT

Objective: Manual dexterity is crucial for daily activities and occupational tasks requiring fine motor control. Diabetes mellitus can negatively affect hand function owing to factors such as abnormal collagen cross-linking, muscle glycosylation, and peripheral neuropathy. While extensive research has focused on diabetes-related foot complications, few studies have examined their effects on hand dexterity, particularly in middle-aged individuals. This cross-sectional study aimed to investigate the impact of diabetes duration on manual dexterity and compare the functional differences between the dominant and non-dominant hands in middle-aged adults.

Methodology: An observational analytical study was conducted on 90 diabetic individuals aged 40–60 years divided into three groups based on disease duration: <5 years, 5–10 years, and >10 years. Manual dexterity was assessed using the Nine-Hole Peg Test (9HPT). Statistical analysis was performed using the Shapiro-Wilk test for normality, followed by the Mann-Whitney U test.

Results: Manual dexterity in diabetes between 40-60 years revealed a significant difference(p-0.001). According to chronicity, individuals with <5 years(p-0.002) and 5-10years (p-0.001) of diabetes also revealed significant differences, except for individuals with >10years of age (p-0.057). The mean difference between dominant and non-dominant individuals with chronicity was also significant difference (p-0.001).

Conclusion: Diabetes significantly impaired manual dexterity, with the non-dominant hand being more affected. The severity of impairment increases with disease duration, but after 10 years, the difference between the hands diminishes. Early assessment and targeted interventions may help to preserve hand function in individuals with diabetes.

Keywords: manual dexterity, diabetes mellitus, nine-hole peg test, motor impairment.

INTRODUCTION

The hand is the most active and interactive part of the upper extremity. Hand dexterity is a term used to explain a range of different hand abilities and performances. The term "hand dexterity" encompasses a variety of hand skills and performances, such as reaction time, hand preference, wrist flexion speed, finger tapping speed, aiming, and the stability of both the hand and arm. Among

these, four primary factors are identified as the most defining and dependable for assessing hand dexterity[1].

Aging is associated with a decline in cognitive and sensorimotor function. For instance, age-related decline in manual dexterity is an important issue to address, because most daily activities require fine and gross motor activities of the hands. The definition of manual dexterity has been formulated by Poirier (1987), a manual skill that requires rapid coordination of gross and fine voluntary movements based on a certain number of capacities, which are developed through learning, training, and experience." Manual Dexterity is the ability to coordinate hand and finger movements to grasp and manipulate objects that include muscular, skeletal, and neurological functions to produce small precise movements[2,3]. These skills are fundamental for individuals to experience and learn about their environment. A decline in manual dexterity is a common phenomenon in elderly individuals. Often, simple daily activities such as handling coins and preparing meals become challenging. A substantial decline in manual dexterity may impact one's ability to live independently[4].

Diabetes mellitus (DM) is a chronic metabolic disease characterized by hyperglycemia and high glycated hemoglobin with or without glycosuria[5]. In diabetes mellitus, because of abnormal cross linking of collagen , it leads to skin thickening and formation of nodules which result in stiff hand [6] . According to International Diabetes Federation Diabetes Atlas, 9th edition 2020 it is projected that the number of people older than 65 years with diabetes will reach 276.2 million by 2045 globally whereas as India ranks second after China in the global diabetes epidemic. With the increase in prevalence of T2DM worldwide and in India, the accompanying complication may disturb activities of daily living and quality of life . Unlike the diabetic foot , complication of hands with T2DM are easily neglected.

The nine hole peg test is a brief, standardized, quantitative test with high inter- rater reliability and good test – retest reliability. It is widely used to assess finger dexterity in clinical settings because of its simplicity, low cost and short time to administer. It is one of the most frequently used upper limb outcome measures in studies[7].

According to earlier research, hand complications in individuals with T2DM can impact daily activities and result in difficulties with self-care tasks. This can lead to diminished social interactions, a loss of autonomy, financial strain, and an overall decline in quality of life[8]. With increasing disease duration, patients experience peripheral neuropathy, glycosylation of skeletal muscle proteins, mitochondrial dysfunction, and elevated pro-inflammatory cytokines such as TNF-α and IL-6, all of which lead to reduced muscle strength and fine motor control[9,10.] The reporting of hand dysfunction in these patients lacks agreement among studies. Thus, considering the increasing rate in number of people living with T2DM and the increased life expectancy, a study of hand function may help improve care, independence in activities of daily living and quality of life. Hence, study aims to find out effect of diabetes in hand dexterity.

METHODOLOGY

This cross-sectional observational study will include a total sample size of 90 participants, divided into three groups based on diabetes duration: less than 5 years, 5-10 years, and more than 10 years (30 participants in each group), selected through convenient sampling. The study will be conducted at a tertiary care center, with a one-time assessment lasting approximately 10 minutes. Participants will include males and females aged 40-60 years, with a known diagnosis of diabetes, and no uncorrected auditory or visual impairments. Individuals with upper limb fractures, cervical spondylosis with radiating pain, neurological conditions such as stroke or

motor neuron disease, or wrist and hand deformities will be excluded from the study to ensure accurate assessment of manual dexterity.

Study Procedure

After obtaining institutional ethical approval, participants will be selected based on the inclusion and exclusion criteria. Informed consent will be taken from all participants, and they will receive a detailed explanation and demonstration of the study procedure. Manual dexterity will be assessed using the Nine-Hole Peg Test (NHPT)**,** performed on both the dominant and non-dominant hands. Upon the start command, a stopwatch will be activated, and the participant will pick up and place nine pegs into the holes one at a time as quickly as possible, then remove them and return them to the container or table. The time taken to complete the task for each hand will be recorded separately for analysis.

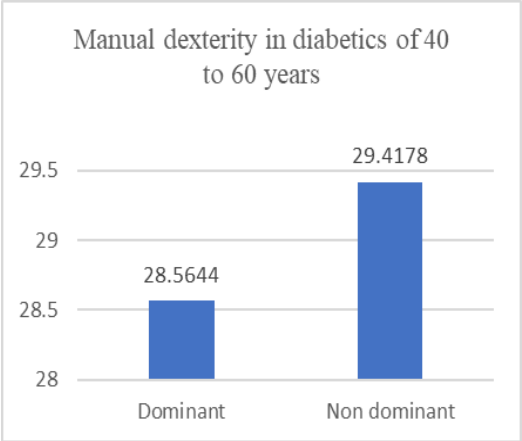
RESULTS

The data analysis was performed using SPSS software. As data was not normally distributed hence Non parametric test (Mann Whitney U test) was performed.

A total of 90 diabetic patients (31 females, 59 males) with a mean age of 49.48 years were included in the study.

Table 1 Manual Dexterity Between Dominant and Non-Dominant Hands in Diabetic Patients (Aged 40-60 Years)

Manual dexterity in diabetes between 40 to 60 years		
	Dominant	**Non dominant**
Mean	28.5644	29.4178
SD	1.73466	1.74836
P value	0.001	significant



Inference: Test revealed significant difference in manual dexterity between the dominant and non-dominant hands of diabetic patients.

TABLE 2: Comparison of Manual Dexterity Between Dominant and Non-Dominant Hands Across Different Diabetes Duration Groups

Diabetes Duration	**Dominant Hand (Mean ± SD)**	**Non-Dominant Hand (Mean ± SD)**	**P-Value**	**Significance**
< 5 Years	28.11 ± 1.33	28.78 ± 1.30	0.002	Significant
5 - 10 Years	27.78 ± 1.25	28.91 ± 1.34	0.001	Significant
> 10 Years	29.80 ± 1.86	30.55 ± 1.96	0.057	Not Significant

Inference - The analysis revealed a significant difference in manual dexterity between the dominant and non-dominant hands in diabetic individuals, except in those with more than 10 years of diabetes, where the difference was not statistically significant.

DISCUSSION

Manual dexterity is a major factor that impair the ability to perform daily and functional activities. Progressive impaired hand dexterity has been shown as the person gets older4. This study included person with diabetes of 40 -60 years of age.

In this study, the Nine-Hole Peg Test (9 HPT) was administered to diabetic patients aged 40 to 60 years. The results indicated a

significant reduction in manual dexterity in both the dominant and non-dominant hands, with a slightly greater reduction observed in the non-dominant hand. Subsequently, the same test was conducted on diabetic individuals categorized by disease duration: less than 5 years, 5 to 10 years, and more than 10 years. It was found that individuals with diabetes for less than 5 years and those with 5 to 10 years exhibited significant differences in dexterity, whereas those with more than 10 years showed no significant difference between the hands. Furthermore, individuals with diabetes for more than 10 years demonstrated a severe reduction in manual dexterity compared to the other two groups.

This reduction of manual dexterity in individuals with diabetics have impaired dominant and non-dominant hand may be because of one of the reasons that the muscle tissues does not regenerate properly in people with diabetes is that it does not produce enough of a key protein. This aligns with previous research suggesting that diabetes-related stiffness in subcutaneous tissues and periarticular structures contributes to reduced hand function (Ayhan et al., 2014). The reduction in hand dexterity in diabetic individuals compared to age-matched healthy individuals can be attributed to increased insulin resistance and hyperglycemia, leading to mitochondrial dysfunction in muscle cells, decreased glycogen synthesis, and elevated levels of systemic inflammatory cytokines such as Tumor Necrosis Factor (TNF-α) and Interleukin-6. These metabolic disturbances contribute to muscle weakness, impaired neuromuscular control, and reduced dexterity in diabetic patients11. Furthermore, studies have shown that soft tissue glycosylation and abnormal collagen cross-linking lead to increased stiffness in the hands, impacting fine motor control (Ramirez et al., 2016) 10. Our findings also support that the chronicity of diabetes further influences hand function, as individuals with a longer disease duration showed greater impairment. However, in those with more than 10 years of diabetes, the difference between dominant and non-dominant hand dexterity was not significant, possibly due to progressive bilateral involvement of neuropathy and musculoskeletal changes (Fain et al., 2017).

We also found that the non-dominant hand dexterity is slightly more affected than the dominant hand dexterity may be due to poor compensatory mechanism of the non-dominant hand 12. Studies suggest that even in healthy individuals, the non-dominant hand has lower precision and fine motor control compared to the dominant hand. When diabetes further impairs hand function, the non-dominant hand may experience a more noticeable decline due to its already lower baseline dexterity. The brain's motor cortex has better neuroplastic adaptations for the dominant hand, which helps maintain function despite disease progression13. The non-dominant hand lacks this adaptive efficiency, making it more vulnerable to the degenerative effects of diabetes.

CONCLUSION

Our study concludes that manual dexterity is impaired in diabetic individuals aged 40-60 years, affecting both the dominant and non-dominant hands. However, the non-dominant hand was significantly affected compared to the dominant hand. Manual dexterity with diabetes duration (chronicity), a significant difference was found in all groups except for individuals with more than 10 years of diabetes, where no significant difference was observed between hands. additionally, a significant difference was found in manual dexterity as dominant hand showed better dexterity than non-dominant hand across all three diabetes duration groups. These findings suggest that diabetes duration influences hand function, with longer disease chronicity leading to greater impairment in manual dexterity.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest: The authors declare that there is no conflict of interest related to this study.

REFERENCES

1. Martin, J. A., Ramsay, J., Hughes, C., Peters, D. M., & Edwards, M. G. (2015). Age and grip strength predict hand dexterity in adults. *PloS one*, *10*(2), e0117598. https://doi.org/10.1371/journal.pone.0117598
2. Bruni, M. (1998). *Fine motor skills in children with Down syndrome: A guide for parents and professionals*. Woodbine House.
3. Sobinov, A. R., & Bensmaia, S. J. (2021). The neural mechanisms of manual dexterity. *Nature Reviews Neuroscience*, *22*(12), 741–757. https://doi.org/10.1038/s41583-021-00528-7
4. Diermayr, G., Mcisaac, T. L., & Gordon, A. M. (2010). Finger Force Coordination Underlying Object Manipulation in the Elderly – A Mini-Review. *Gerontology*, *57*(3), 217–227. https://doi.org/10.1159/000295921
5. Mohan M, Thombre DP, Das AK, Subramanian N, Chandrasekar S. Reaction time in clinical diabetes mellitus. Indian J Physiol Pharmacol. 1984;28(4):311-314.
6. Prevalence of hand disorders in type 2 diabetes mellitus and its correlation with microvascular complications. *Annals of medical and health sciences research*, *3*(3), 349–354. https://doi.org/10.4103/2141-9248.117942
7. Mathiowetz V, Weber K, Kashman N, Volland G. Adult Norms for the Nine Hole Peg Test of Finger Dexterity. The Occupational Therapy Journal of Research. 1985;5(1):24-38.
8. Casanova, J. E., Casanova, J. S., & Young, M. J. (1991). Hand function in patients with diabetes mellitus. *Southern medical journal*, *84*(9), 1111-1113.
9. Sharma V, Aggarwal S, Sharma A. Diabetes in elderly. *J Endocrinol Metab*. 2011;1(2):64–72. doi: 10.4021/jem11e
10. Ramirez J, Cortés R, González P, Fernández D. Structural changes in diabetic hands: A clinical and histological review. *J Musculoskelet Res*. 2016;19(3):203–210. doi: 10.1142/S0218957716500114
11. Rehab N, Abdelmageed S, Abu El Kasem S, Tawfik R. Effect of hand exercises program on wrist proprioception, grip strength and hand function in patients with type 2 diabetic polyneuropathy: A randomized controlled trial. *J Med Sci*. 2021; 32:8278–8289.
12. Özcan, A., Tulum, Z., Pınar, L., & Başkurt, F. (2004). Comparison of Pressure Pain Threshold, Grip Strength, Dexterity and Touch Pressure of Dominant and Non-Dominant Hands within and Between Right- and Left-Handed Subjects. *Journal of Korean Medical Science*, *19*(6), 874. https://doi.org/10.3346/jkms.2004.19.6.874
13. Ruffino, C., Papaxanthis, C., & Lebon, F. (2017). Neural plasticity during motor learning with motor imagery practice: Review and perspectives. *Neuroscience*, *341*, 61–78. https://doi.org/10.1016/j.neuroscience.2016.11.023

How to cite this article: Sadhana Dharmraj Chougule, Bhagyashree Kamble, Medha Deo. Effect of diabetes duration on dominant and non-dominant hand dexterity in middle-aged adults: a cross-sectional study. *Int J Health Sci Res.* 2025; 15(4):48-52.
DOI: *https://doi.org/10.52403/ijhsr.20250407*

******