Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i4.5572

A COMPARATIVE STUDY ON COGNITIVE IMPAIRMENT AMONG ADULTS WITH TYPE 2 DIABETES MELLITUS

Dr. Ankeeta R Vispute (PT)[1*], Dr. Larissa A Dsouza (PT)[2]

[1*,2]DY Patil University, School of Physiotherapy, Navi Mumbai, Maharashtra, India.

***Corresponding Author:** Dr. Ankeeta R Vispute
*DY Patil University, School of Physiotherapy, Navi Mumbai, Maharashtra, India.

Abstract-

Context: Cognitive impairment is a relatively less known and less addressed complication of diabetes. It is a concern because it adversely affects disease self-management resulting in further complications. The incidence of cognitive impairment in adults with diabetes has been demonstrated in a small number of research, particularly when using the MoCA (The Montreal Cognitive Assessment) score, which assesses various domains of cognition.

Aims: The aim of the study is to investigate the prevalence of cognitive impairment in adults with type 2 diabetes mellitus and to identify other potential predictors for cognitive impairment.

Settings and Design: Comparative study in non-diabetics and diabetics

Methods and Material: 60 people participated in the study. They were further divided into Non-Diabetics (Group A) and Diabetics (Group B). The MoCA score was used to screen for cognitive impairment.

Statistical analysis used: Statistical analysis was done using Microsoft Excel and SPSSv.29. Subjects with cognitive impairment did not show significant association with disease characteristics such as duration of diabetes [*P* 0.240] and control of diabetes [*P* 0.192].

Results: Most of the diabetic population were females that had cognitive impairment. The total MoCA score in diabetics [mean- 21] was less compared to the non-diabetic patients [mean-28]. The diabetics also scored lower on every domain of MoCA when compared to the non-diabetic group. However, not all domains were affected the same.

Conclusions: This study concludes that cognitive impairment was present in most of the diabetic population. Duration of diabetes and Control of diabetes did not show an association with cognitive impairment.

Keywords- Type 2 Diabetes mellitus, Cognitive Impairment, The Montreal Cognitive Assessment

Introduction

Diabetes mellitus type 2 is a chronic, intricate metabolic condition. [1] The primary symptom hyperglycemia is a clinical manifestation of a progressive decrease of beta-cell mass and/or function

that can be caused by a multitude of hereditary and environmental causes. Genetic and environmental risk factors impact inflammation, autoimmune diseases, and metabolic stress. Various factors modify the mass and/or function of beta cells to the extent that insulin levels eventually lose their ability to respond to insulin demands, leading to hyperglycemia levels that are high enough to diagnose diabetes. On rare occasions, cell mass and/or function may be directly impacted by genetic and environmental risk factors. [2] In addition to lowering the quality of life, it has microvascular and macrovascular consequences. [1] Perception, memory, learning, attention, decision-making, and language skills are all areas of cognitive function.[3] Cognitive impairment is the term used to describe problems with memory, learning new things, focus, or making decisions that affect day-to-day functioning. [4] Cognitive impairment is likely to be a barrier to providing appropriate medical treatment, especially in patients with chronic diseases, as it may hinder patients' comprehension of the need for therapy, routine follow-up, and self-care. [5] Diabetes mellitus is associated with changes in the structure of the brain and cognitive impairment. When compared to non-diabetic controls, neuropsychological testing has shown that persons with both type 1 and type 2 diabetes have mild to moderate deficits in cognitive performance. Type 2 diabetes (T2DM) has also been associated with a 50% increased risk of dementia.[6] In the early 20th century, medical professionals and researchers started to observe that people with diabetes frequently complained about having problems focusing and remembering things. In 1922, Mile et al. provided evidence that people with diabetes had difficulty in memory and attention tests.[7] Research connecting dementia with type 2 diabetes indicates that cognitive impairment increases the risk of severe hypoglycemic episodes, cardiovascular diseases, stroke, and early mortality.[8] Furthermore, it has been demonstrated that glucose and insulin imbalances, macrovascular and microvascular comorbidities, and other diabetes-related issues significantly raise a patient's chance of getting MCI and progressing it to dementia. [9] Numerous risk factors for cognitive dysfunction in diabetes were found, including age, depression, length of diabetes, and educational attainment of the patient.[10] Cognitive impairment is a relatively lesser known and lesser addressed complication of diabetes. It is concerning since it leads to disability and higher medical expenses. Cognitive impairment can also have a negative impact on diabetes-related self-management. [11] A few studies from India have shown cognitive impairment in type 2 diabetes mellitus, however limited studies used the MoCA score, which is regarded by many as the best tool to assess mild cognitive impairment.[12] Thus, establishing a link between type 2 diabetes and cognitive impairment will help advocate early screening programs. Also, identification of cognitive domains affected due to diabetes would help in formulating a better diagnosis and intervention plan for the affected adults.

Materials And Methods:

Ethics:

Approved by ethical committee.

Study design and subjects:

The present study was a cross-sectional study. 30 individuals with type 2 diabetes mellitus were included in the study (Group B). These individuals belonged to both the genders, age between 45 - 80 years old, having type 2 diabetes mellitus for more than 5 years. The exclusion criteria were neurological conditions that were known to affect cognition such as Stroke, Parkinsons, Traumatic brain injury, Tumours, Alzheimer’s etc, pre-diagnosed psychological disorders, speech and hearing disabilities, pregnancy and uncooperative or individuals not willing to participate in the study. For comparison, a group of 30 normal, healthy individuals with no co morbidities were recruited with age between 45-80 years old and included both the genders. (Group A)

Outcome measure:

The participants in the study were assessed using the Montreal Cognitive Assessment (MoCA). This tool is quick to screen for mild cognitive impairment. A variety of cognitive domains are evaluated, including executive functions, language, attention and focus, memory, visuo-constructional skills,

conceptual thinking, computations, and orientation. A score of 26 or above is regarded as normal; a maximum score of 30 points is possible. If the length of formal education was shorter than 12 years, a point was added to the final score. With a 90% sensitivity and 87% specificity at a 26-point cut-off, the MoCA is a valid and dependable tool for routine neurocognitive function screening. [13]

Procedure:

The individuals were evaluated based on the inclusion and exclusion criteria and were explained about the objectives and procedures prior to the participation. A written consent was taken from every individual participating in the study.

The individuals were administered the MoCA (The Montreal Cognitive Assessment) and their response was recorded. Based on their response, the total score was calculated. A point was added to the total score if the number of years of formal education was less than 12 years. The scores were analysed using MS Excel and SPSS software. Comparisons were made in both the groups and appropriate recommendations were presented. (Fig. 1)

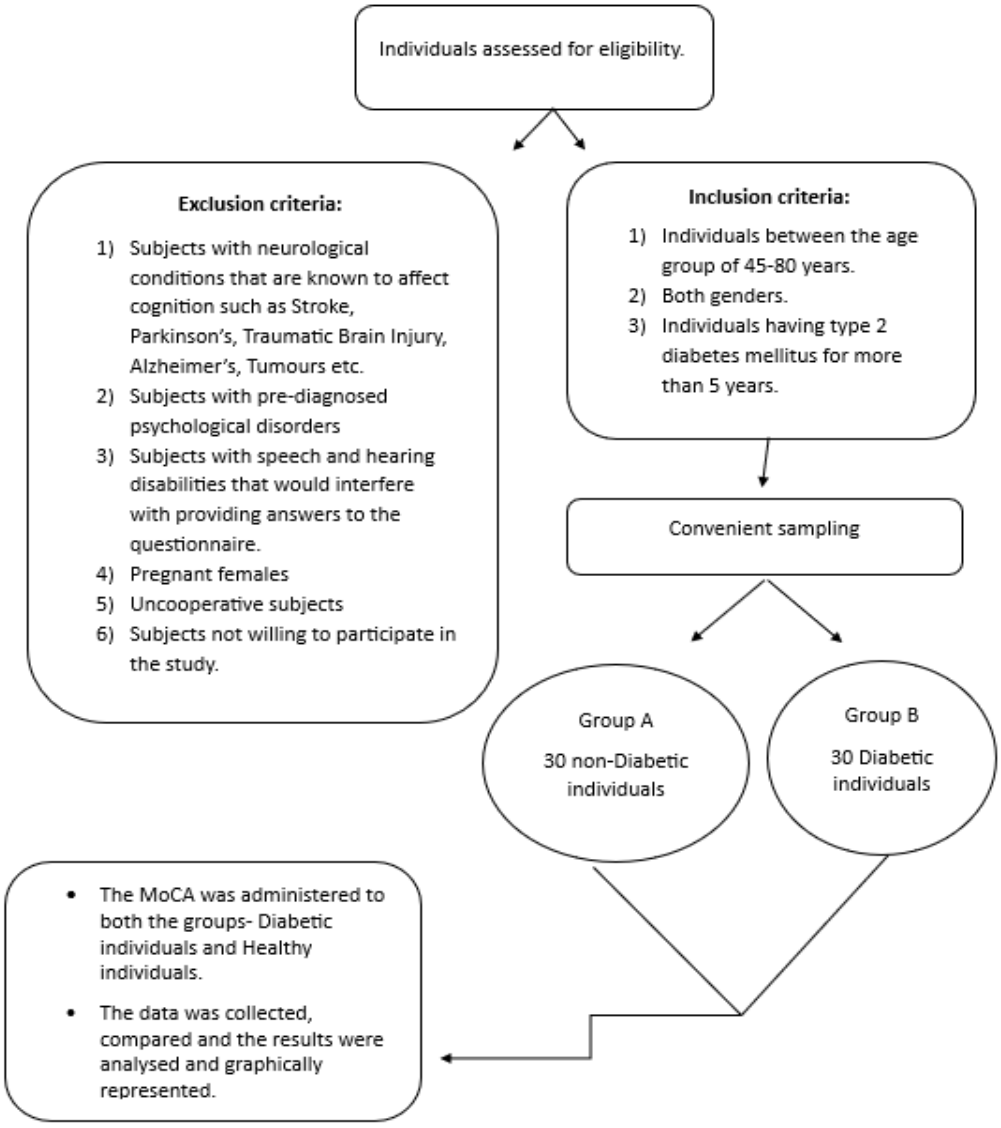

Fig. 1: Diagram showing a schematic summary of the participants recruited for this study.

Results:

A total of 60 adults participated, among which Group A had 17 males and 13 females while Group B had 10 males and 20 females. The mean age was 52.9 years and 64.73 years in Group A and Group B respectively. [Table 1] Cognitive impairment was present in 80% (24) of Group B when compared

to Group A. Group A did not present with cognitive dysfunction. [Table 2] The total MoCA score in Group B was less compared to Group A. Group B scored lower on every domain of MoCA when compared to Group A. However, not all domains were affected the same. [Table 3] Those with cognitive impairment did not show significant association with disease characteristics such as duration of diabetes [*P* 0.240] [Table 4] and control of diabetes [*P* 0.192]. [Table 5]

Table 1: Subjects' gender and age distribution

	Group A (n=30)	**Group B (n=30)**
Male	17	10
Female	13	20
Age (in years) Mean±SD	52.9±6.83	64.7±8.56

Table 2: Cognitive impairment in the subjects

	Group A (n=30)		**Group B (n=30)**	
	n	%	n	%
Cognitive Impairment				
Present	0	0%	24	80%
Absent	30	100%	6	20%

Table 3: Comparison of Scores obtained in MoCA of subjects.

	Group A	**Group B**	**Change percentage**
Mean score (In points)			
Total score	28.13	21.13	-33.13%
Executive	4.4	3.16	-39.24%
Naming	3	2.66	-12.8%
Attention	5.63	3.9	-44.36%
Language	2.7	1.3	-107.7%
Abstraction	1.96	1.3	-50.77%
Delayed Recall	4.03	2.5	-61.25%
Orientation	6	5.83	-2.91%

Table 4: Relationship of Duration of diabetes with cognitive impairment

	Cognitive Impairment present		**Cognitive Impairment absent**		***P* value**
	n	%	n	%	
Duration of diabetes					0.240
More than 5 years	7	23.33%	0	0%	
More than 10 years	4	13.34%	3	10%	
More than 15 years	7	23.33%	2	6.67%	
More than 20 years	6	20%	1	3.33%	

Table 5: Relationship of Control of diabetes with cognitive impairment

	Cognitive Impairment present		**Cognitive Impairment absent**		***P* value**
	n	%	n	%	
Control of diabetes					0.192
Controlled	13	43.33%	5	16.67%	
Uncontrolled	11	36.67%	1	3.33%	

Discussion:

This study showed that majority of the diabetic individuals had cognitive impairment. This is in line with the previous research that also found majority of the diabetic individuals presented with cognitive impairment on examination compared to those without diabetes. [14,19] Diabetic individuals were more likely to present with decline in cognition as compared to their normal counterparts. This finding was also corroborated when the total scores of MoCA were compared in both the groups. This is consistent with research showing a high frequency of cognitive impairment in people with type 2

diabetes. [15,16,17] Beta amyloid, a protein crucial to brain growth and repair, has been linked to elevated deposition and impaired clearance in diabetes. In addition to raising the risk of cognitive impairment on its own, diabetes is also linked to increased cardiovascular risk and macro- and microvascular brain illness. These conditions also contribute to the development of cognitive impairment in diabetes. [16]

A differentiating factor in this study was the absence of cognitive impairment in the control group. In a study done by Varghese SM, Joy N et al., over 10% of the non-diabetic individuals were found to be cognitively impaired.[14] The absence of a similar finding may be because the control group in this study consisted majorly of individuals in the 40-60 years age group. According to a Centres for Disease Control and Prevention study, the prevalence of cognitive decline was 11.7% in individuals 65 years of age and above and 10.8% in adults 45 to 64 years of age. [18] This may be the reason for the lack of cognitively impaired individuals in the control group.

This study examined the relationship between the duration of diabetes and cognitive impairment. The p-value was found to be insignificant. This shows that cognitive impairment did not have a significant relationship with the duration of diabetes. The present discovery aligns with earlier research findings, which indicated that a prolonged history of diabetes seems to be a significant risk factor for cognitive impairment, with patients even experiencing symptoms early in the illness. [19,21] However, a study by Roberts RO, et al. found that the length of diabetes was linked to cognitive impairment, particularly in those with diabetes for more than ten years. This association was explained by the possibility that long-term episodes of hypo- or hyperglycemia could cause neuronal loss and microangiopathy, which would raise the risk of cognitive impairment. [16]

Research was also done on the connection between diabetes management and cognitive decline. Poorly managed diabetes has been linked to an increased risk of cognitive impairment, according to prior study. [14,20] However, this investigation did not discover a meaningful connection between diabetes management and cognitive decline. Majority of the cognitively impaired individuals reported their blood sugar levels to be under control. These individuals represented about 43.33% (13) of the population in contrast to the 36.67% (11) of the population who had uncontrolled diabetes and were found to be cognitively impaired. The *P* value was found to be insignificant proving no relationship between Control of diabetes and cognitive impairment.

Each MoCA domain—naming, attention, language, abstraction, delayed recall, orientation, and visuospatial/executive functions—was examined in this study between Groups A and B. The diabetics scored averagely lower on every domain when compared to the control group. However, not all domains were affected the same. The most affected domain was found to be the language domain (verbal fluency) which showed a -107.7% change when the scores were compared. This was followed by delayed recall component and the abstraction component with the change being -61.2% and -50.7% respectively. The orientation domain was the least affected with a change percentage of a little over -2%. According to the findings of an Indian study on the relationship between diabetes and cognition, verbal memory and processing speed were the most negatively impacted cognitive functions, while visuospatial function, attention, semantic memory, and language were unaffected. [19] The results of this study are consistent with that of Naguib et al.'s study, which also indicated that verbal fluency and delayed recollection were the domains most negatively impacted. [20] The least affected domains were naming and scoring, but the percentages of deficits were similar for the abstract, alternating trial making, and visuospatial/executive domains. Determining which cognitive domains are most impacted by diabetes is crucial for lowering the risk of cognitive impairment. This can be achieved by putting cognitive rehabilitation therapies—which are important to enhance executive functioning—into practise, such as exercise and physical activity. [11]

From a clinical standpoint, the high prevalence of cognitive impairment is critical because patients with cognitive impairment may find it difficult to carry out complex self-care tasks like meal planning, which increases the risk of hypoglycemia by preventing them from consuming meals, adhering to an exercise schedule that improves blood glucose control, regularly checking their blood sugar, and taking multiple oral diabetic medications and adjusting their dosages. Inadequate self-care

can ultimately lead to inadequate regulation of metabolism, hence raising the likelihood of diabetic complications. Some limitations of our investigation deserve consideration. The sample size chosen was small and the associations ascertained were rather general and some confounding factors may have been missed. Next, not all factors that may affect cognitive impairment were assessed and not all factors that may affect type 2 diabetes mellitus were assessed.

References:

1. Kanter JE, Bornfeldt KE. Impact of Diabetes Mellitus. Arterioscler Thromb Vasc Biol. 2016 Jun;36(6):1049-53. doi: 10.1161/ATVBAHA.116.307302. PMID: 27225786; PMCID: PMC4 972454.
2. Skyler JS, Bakris GL, Bonifacio E, Darsow T, Eckel RH, Groop L, Groop PH, Handelsman Y, Insel RA, Mathieu C, McElvaine AT, Palmer JP, Pugliese A, Schatz DA, Sosenko JM, Wilding JP, Ratner RE. Differentiation of Diabetes by Pathophysiology, Natural History, and Prognosis. Diabetes. 2017 Feb;66(2):241-255. doi: 10.2337/db16-0806. Epub 2016 Dec 15. PMID: 27980006; PMCID: PMC5384660.
3. Kiely, K.M. (2014). Cognitive Function. In: Michalos, A.C. (eds) Encyclopedia of Quality of Life and Well-Being Research. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0753-5_426
4. Cognitive Impairment: A Call for Action Now! Centers for Disease Control and Prevention. www.cdc.gov/aging/pdf/ cognitive_impairment/cogimp_poilicy_final.pdf.
5. Alosco ML, Spitznagel MB, van Dulmen M, et al. Cognitive function and treatment adherence in older adults with heart failure. Psychosom Med. 2012 Nov-Dec;74(9):965-973. doi: 10.1097/PSY.0b013e318272ef2a.
6. Biessels GJ. Risk of dementia in diabetes mellitus: a systematic review. Lancet Neurology The. 5:64–74.
7. Miles WR, Root HF. Psychologic tests applied to diabetic patients. Arch Intern Med. 1922;30:767–777.
8. American Diabetes Association 12 Older Adults: Standards of Medical Care in Diabetes—2019. Diabetes Care. 2018;42:S139–S147. doi: 10.2337/dc19-s012.
9. Biessels G.J., Despa F. Cognitive decline and dementia in diabetes mellitus: Mechanisms and clinical implications. Nat. Rev. Endocrinol. 2018;14:591–604. doi: 10.1038/s41574-018-0048-7.
10. Pal K., Mukadam N., Petersen I., Cooper C. Mild cognitive impairment and progression to dementia in people with diabetes, prediabetes and metabolic syndrome: A systematic review and meta-analysis. Soc. Psychiatry. 2018;53:1149–1160. doi: 10.1007/s00127-018-1581-3.
11. Palta P, Carlson MC, Crum RM, Colantuoni E, Sharrett AR, Yasar S et al (2017) Diabetes and cognitive decline in older adults: the ginkgo evaluation of memory study. J Gerontol A Biol Sci Med Sci 73(1):123–130
12. Lalithambika CV, Arun CS, Saraswathy LA, Bhaskaran R. Cognitive Impairment and its Association with Glycemic Control in Type 2 Diabetes Mellitus Patients. Indian J Endocrinol Metab. 2019 May-Jun;23(3):353-356. doi: 10.4103/ijem.IJEM_24_19. PMID: 31641638; PMCID: PMC6683683.
13. Mahendran, R., Chua, J., Feng, L., Kua, E., & Preedy, V. (2015). The Mini-Mental State Examination and Other Neuropsychological Assessment Tools for Detecting Cognitive Decline. *Diet and Nutrition in Dementia and Cognitive Decline*, 1159-1174. https://doi.org/10.1016/B978-0-12-407824-6.00109-9
14. Varghese SM, Joy N, John AM, George G, Chandy GM, Benjamin AI. Sweet Memories or Not? A Comparative Study on Cognitive Impairment in Diabetes Mellitus. Front Public Health. 2022 Feb 4;10:822062. doi: 10.3389/fpubh.2022.822062. PMID: 35186849; PMCID: PMC8854745.
15. Zilliox LA, Chadrasekaran K, Kwan JY, Russell JW. Diabetes and Cognitive Impairment. Curr Diab Rep. 2016 Sep;16(9):87. doi: 10.1007/s11892-016-0775-x. PMID: 27491830; PMCID: PMC5528145.

16. Roberts RO, Geda YE, Knopman DS, Christianson TJ, Pankratz VS, Boeve BF, Vella A, Rocca WA, Petersen RC. Association of duration and severity of diabetes mellitus with mild cognitive impairment. Arch Neurol. 2008 Aug;65(8):1066-73. doi: 10.1001/archneur.65.8.1066. PMID: 18695056; PMCID: PMC2630223.
17. Diabetes Is Associated with Cognitive Decline in Middle-Aged Patients. Michael Palacios-Mendoza, Maria Beatriz Jurado, Ximena Gamboa, Carlos Cevallos, Daniel Moreno-Zambrano, Maria Carolina Duarte, Carlos Penaherrera, Leonardo Tamariz, Ana Palacio, and Rocio Santibanez. Metabolic Syndrome and Related Disorders 2018 16:10, 514-520.
18. "Subjective Cognitive Decline — A Public Health Issue." CDC.GOV, 30 Jul. 2019, www.cdc.gov/aging/aginginfo/subjective-cognitive-decline-brief.html.
19. Yerrapragada DB, Rao CR, Karunakaran K, Lee HSE (2019) Cognitive dysfunction among adults with type 2 diabetes mellitus in Karnataka, India. Ochsner J 19(3):227–234
20. Naguib, R., Soliman, E.S., Neimatallah, F.M. et al. Cognitive impairment among patients with diabetes in Saudi Arabia: a cross-sectional study. Middle East Curr Psychiatry 27, 49 (2020). https://doi.org/10.1186/s43045-020-00058-5
21. Ruis C, Biessels GJ, Gorter KJ, et al. Cognition in the Early Stage of Type 2 Diabetes. Diabetes Care. 2009;32:1261–1265.