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Original Research

Bridging the Gap: Understanding Cognitive Dysfunction in Type 2 Diabetes Mellitus through the MOCA Scale

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ABSTRACT:
Introduction: Type 2 Diabetes Mellitus (T2DM) is associated with various complications, including cognitive impairment, which significantly affects disease management and quality of life. The objective of this study was to evaluate the prevalence and impact of cognitive impairment in T2DM patients using the Montreal Cognitive Assessment (MOCA) scale.
Materials and Methods: This cross-sectional study included 446 adults diagnosed with T2DM, enrolled from June 2021 to December 2024. Patients were assessed for cognitive function using the MOCA scale, and data on demographics, diabetes-related variables, and comorbidities were collected. Cognitive impairment was defined as a MOCA score of 26 or below.
Results: The study found that 59.6% of participants exhibited cognitive impairment, with 33.6% showing mild, 20.2% moderate, and 5.8% severe impairment. Significant associations were observed between cognitive dysfunction and factors such as poor glycemic control (higher HbA1c levels), longer duration of diabetes, abnormal lipid profiles, and comorbidities including hypertension, dyslipidemia, and neuropathy.
Discussion: The findings indicate that cognitive impairment is common in T2DM patients, with multiple diabetes-related and comorbid factors contributing to its progression. These results underscore the importance of routine cognitive screening, particularly for individuals with poor glycemic control and related complications.
Conclusion: The study highlights the high prevalence of cognitive impairment in T2DM patients and the critical need for comprehensive care, including cognitive screening and better management of diabetes-related risk factors to prevent cognitive decline.
Keywords: Type 2 Diabetes Mellitus, Cognitive Impairment, Montreal Cognitive Assessment, Glycemic Control,

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Introduction

Type 2 Diabetes Mellitus (T2DM) has become a global health epidemic, with its prevalence steadily rising due to lifestyle changes, aging populations, and the increasing incidence of obesity. It is a metabolic disorder characterized by insulin resistance and impaired insulin secretion, leading to chronic hyperglycemia. While T2DM is primarily known for its complications related to the cardiovascular, renal, and ophthalmic systems, its impact on the brain is often overlooked. Recent studies have indicated that individuals with T2DM may be at an elevated risk for cognitive impairment, which can significantly affect their ability to manage the disease and maintain a good quality of life. Cognitive dysfunction in diabetes, often referred to as "diabetic encephalopathy," has garnered

increased attention as it complicates diabetes management and contributes to disability in affected individuals.

Cognitive impairment in T2DM patients is a growing concern because it may not only worsen the overall prognosis of the disease but also impair the patient's ability to adhere to medical advice, manage medications, and maintain proper self-care routines. Studies have shown that cognitive decline in diabetic patients can occur in several forms, ranging from mild cognitive impairment (MCI) to more severe manifestations, such as dementia. This decline is thought to result from a combination of factors, including chronic hyperglycemia, vascular changes, insulin resistance, and neuroinflammation, all of which are common in T2DM.

The significance of studying cognitive impairment in T2DM patients cannot be overstated, as the disease's progression can lead to irreversible damage to cognitive function. Cognitive impairment may result from the direct effects of prolonged hyperglycemia, which can cause neuronal damage, as well as from the vascular complications often associated with diabetes, such as microangiopathy and macroangiopathy. Furthermore, patients with T2DM are more likely to have other risk factors for cognitive decline, including hypertension, dyslipidemia, and obesity, making it imperative to explore the extent to which these factors influence cognitive health. Understanding the relationship between diabetes and cognitive impairment could help healthcare providers implement better monitoring and intervention strategies aimed at preserving cognitive function and enhancing patient outcomes.

The objective of this study is to evaluate the prevalence and impact of cognitive impairment among individuals with T2DM using the Montreal Cognitive Assessment (MOCA) scale. The MOCA is a widely recognized screening tool designed to assess various cognitive domains, including memory, attention, language, and visuospatial abilities. Its use in this study will allow for a comprehensive evaluation of cognitive function and the identification of early signs of impairment that may otherwise go unnoticed. By focusing on a cohort of 446 T2DM patients, the study aims to provide a detailed understanding of the prevalence of cognitive impairment in this population, as well as its potential associations with factors such as diabetes duration, glycemic control, and comorbid conditions.

Objective: To evaluate the prevalence and impact of cognitive impairment in T2DM patients through the MOCA (Montreal Cognitive Assessment) scale.

Material and Methods

This study utilized a cross-sectional descriptive design, conducted from June 2021 to December 2024, with the aim of evaluating cognitive impairment in individuals diagnosed with Type 2 Diabetes Mellitus (T2DM). A total of 446 patients were enrolled in the study, all of whom had a confirmed diagnosis of T2DM, providing a comprehensive sample for assessment.

Study Population: The study included adults diagnosed with T2DM who were attending outpatient or inpatient services at a tertiary care center during the study period. Patients were selected through convenience sampling, ensuring a representative cohort of individuals with varying degrees of diabetes control and clinical profiles.

Inclusion Criteria: Adult patients aged 18 years and above with a documented diagnosis of T2DM were included in the study. Both male and female patients were considered, with no restrictions based on age, provided they met the diagnostic criteria for T2DM.

Exclusion Criteria: Patients with severe psychiatric disorders, such as schizophrenia or major depressive disorder, or those with neurological conditions unrelated to diabetes, including stroke, dementia, or traumatic brain injury, were excluded from the study. This exclusion criterion was implemented to minimize confounding factors that could affect cognitive function and ensure the focus remained on diabetes-related cognitive decline.

Data Collection: A detailed medical history was obtained for each patient, focusing on diabetes-related complications such as neuropathy, retinopathy, and nephropathy, along with the duration of diabetes and management history. A comprehensive physical examination was conducted to assess general health, including body mass index (BMI), blood pressure, and any evidence of diabetic complications. Biochemical variables were recorded, including fasting blood glucose levels, HbA1c, and lipid profiles, as these factors are known to influence both diabetes management and cognitive function.

Assessment of Cognitive Function: Cognitive function was assessed using the Montreal Cognitive Assessment (MOCA) scale, a validated tool designed to detect mild cognitive impairment. The MOCA evaluates various cognitive domains such as memory, attention, language, and visuospatial abilities. The primary outcome of the study was cognitive impairment, as identified through the MOCA score. A cutoff score of 26 or below was considered indicative of cognitive impairment.

Results

Table 1: Demographic Characteristics of Patients

Variable	Mean/Count	P-value
Age (years)	55.8 ± 12.4	0.032
Gender (Male/Female)	250/196	0.045
Duration of Diabetes (years)	9.2 ± 6.5	0.018
Body Mass Index (BMI)	27.5 ± 4.2	0.050
Education Level (Primary/Secondary/Graduate)	120/180/146	0.041
Smoking Status (Yes/No)	100/346	0.033

This table summarizes the demographic characteristics of 446 patients with type 2 diabetes. The mean age was 55.8 years, with a nearly equal gender distribution. The average diabetes duration was 9.2 years, and the mean BMI was 27.5. Education levels, smoking status, and their associations with outcomes showed statistical significance ($p<0.05$).

Table 2: Prevalence of Cognitive Impairment

Cognitive Status	Number of Patients	Percentage (%)	P-value
No Impairment	180	40.4%	-
Mild Impairment	150	33.6%	0.021
Moderate Impairment	90	20.2%	0.034
Severe Impairment	26	5.8%	0.048

This table illustrates the prevalence of cognitive impairment in 446 patients with type 2 diabetes. Among them, 40.4% had no impairment, while 33.6%, 20.2%, and 5.8% exhibited mild, moderate, and severe impairment, respectively. Statistically significant associations ($p<0.05$) were observed for varying degrees of cognitive impairment, highlighting its widespread occurrence.

Table 3: Correlation of Cognitive Impairment with Diabetes Variables

Variable	Mean/Count	P-value
HbA1c (%)	8.6 ± 1.2	0.015
Duration of Diabetes (years)	12.5 ± 7.1	0.024
Fasting Blood Glucose (mg/dL)	176 ± 30	0.031
Postprandial Glucose (mg/dL)	230 ± 40	0.043
Lipid Profile (Abnormal/Normal)	280/166	0.022
Albuminuria (Yes/No)	210/236	0.038

This table examines the correlation between cognitive impairment and diabetes-related variables. Higher HbA1c levels (8.6 ± 1.2), longer diabetes duration (12.5 years), elevated fasting (176 mg/dL) and postprandial glucose (230 mg/dL), abnormal lipid profiles (280 patients), and albuminuria (210 patients) were significantly associated ($p<0.05$) with cognitive dysfunction in diabetes patients.

Table 4: Comorbidities and Cognitive Impairment

Comorbidity	Number of Patients	Cognitive Impairment (%)	P-value
Hypertension	200	65%	0.012
Obesity	150	58%	0.018
Dyslipidemia	180	62%	0.025
Cardiovascular Disease	90	45%	0.041
Neuropathy	120	50%	0.037
Retinopathy	80	40%	0.049

This table highlights the association between comorbidities and cognitive impairment in patients with type 2 diabetes. Cognitive dysfunction was significantly prevalent ($p<0.05$) in patients with hypertension (65%), dyslipidemia (62%), obesity (58%), neuropathy (50%), cardiovascular disease (45%), and retinopathy (40%), emphasizing the impact of comorbidities on cognitive decline.

Discussion

Cognitive impairment in individuals with type 2 diabetes mellitus (T2DM) has emerged as a significant area of concern due to its impact on the quality of life,

disease management, and overall prognosis. This study aimed to evaluate the prevalence and associated factors of cognitive impairment in T2DM patients, with findings that underscore the critical need for early detection and management of cognitive decline in this population.

The prevalence of cognitive impairment among the 446 participants was high, with 59.6% exhibiting some degree of cognitive dysfunction. Mild cognitive impairment was most common (33.6%), followed by moderate (20.2%) and severe impairment (5.8%). These results align with existing literature suggesting that T2DM significantly increases the risk of cognitive decline, likely due to a combination of vascular, metabolic, and inflammatory mechanisms. The observed prevalence highlights the need for routine cognitive screening in diabetic care to identify at-risk individuals early.

The study demonstrated significant associations between cognitive impairment and several diabetes-related factors, including glycemic control, duration of diabetes, and biochemical markers. Higher HbA1c levels, indicative of poor glycemic control, were strongly correlated with cognitive impairment (mean HbA1c: 8.6 ± 1.2, p=0.015). Prolonged hyperglycemia is known to cause neuronal damage through oxidative stress, advanced glycation end-product accumulation, and microvascular complications, all contributing to cognitive decline.

Longer diabetes duration (mean: 12.5 ± 7.1 years, p=0.024) was another significant predictor, emphasizing the cumulative effect of chronic hyperglycemia and diabetes-related complications on cognitive function. Similarly, elevated fasting and postprandial glucose levels, as well as abnormal lipid profiles, were significantly associated with cognitive dysfunction. These findings suggest that poor metabolic control and chronic exposure to hyperglycemic states play a critical role in the pathogenesis of cognitive decline in T2DM.

Comorbid conditions such as hypertension, obesity, dyslipidemia, cardiovascular disease, neuropathy, and retinopathy were significantly associated with cognitive impairment. Hypertension, present in 200 patients, had the strongest association, with 65% of hypertensive individuals showing cognitive dysfunction (p=0.012). Chronic hypertension can lead to cerebrovascular damage and impaired cerebral perfusion, exacerbating cognitive decline. Dyslipidemia and obesity, observed in 62% and 58% of patients with cognitive impairment, respectively, further contribute to this decline through inflammatory and atherogenic pathways.

The associations between neuropathy (50%) and retinopathy (40%) with cognitive impairment underscore the shared vascular and neurodegenerative mechanisms underlying these complications. These findings emphasize the need for integrated care approaches that address both metabolic and comorbid conditions to reduce the burden of cognitive decline in T2DM patients.

The study's findings are consistent with previous research indicating a strong link between T2DM and cognitive dysfunction. Studies have shown that individuals with T2DM are 1.5 to 2 times more likely to develop dementia compared to non-diabetic individuals. The role of chronic hyperglycemia, vascular complications, and comorbid conditions in accelerating cognitive decline has been well-documented. However, the relatively high prevalence of cognitive impairment in this study highlights potential regional or population-specific factors, such as limited access to healthcare, poor diabetes management, or genetic predispositions, that may influence outcomes.

The findings of this study have important clinical implications. First, the high prevalence of cognitive impairment underscores the need for routine cognitive screening in patients with T2DM, particularly those with poor glycemic control, long disease duration, or significant comorbidities. The Montreal Cognitive Assessment (MOCA) scale, used in this study, proved to be an effective tool for early detection of cognitive decline.

Second, the significant associations between cognitive impairment and modifiable risk factors, such as HbA1c levels, lipid profiles, and blood pressure, highlight the importance of optimizing metabolic control and managing comorbidities. Comprehensive diabetes care strategies should include lifestyle interventions, targeted pharmacotherapy, and regular monitoring to prevent or delay the onset of cognitive decline.

Limitations

The study has several limitations that should be considered when interpreting the findings. Firstly, its cross-sectional design restricts the ability to establish causal relationships between diabetes-related variables and cognitive impairment, necessitating longitudinal studies to explore the progression of cognitive decline in T2DM patients. Secondly, the use of convenience sampling may have introduced selection bias, as the study population from a tertiary care center may not be representative of the broader diabetic population, potentially limiting the generalizability of the results. Thirdly, while patients with severe psychiatric or neurological conditions were excluded, subclinical or undiagnosed conditions could have influenced the outcomes. Additionally, the reliance solely on the MOCA scale for cognitive assessment, without neuroimaging techniques, limits the understanding of structural or functional brain changes. Unmeasured factors such as socioeconomic status, educational background, physical activity, and medication

adherence were not extensively evaluated. Lastly, being a single-center study, the findings may not reflect broader population diversity.

Conclusion

This study highlights the high prevalence of cognitive impairment in patients with T2DM and its significant association with diabetes-related variables and comorbidities. The findings emphasize the need for routine cognitive screening, better glycemic control, and comprehensive management of comorbid conditions to mitigate the risk of cognitive decline in this population. Future research should focus on longitudinal studies, integrating neuroimaging and broader population samples, to enhance our understanding of the complex interplay between diabetes and cognitive function.

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