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Assessment of Cognitive Abilities in Individuals with Type 2 Diabetes Mellitus at a Tertiary Health Care Center

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ABSTRACT

Introduction: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder with known vascular complications. However, cognitive dysfunction remains an underrecognized yet significant complication. Hyperglycemia, insulin resistance, and associated metabolic disturbances may lead to neurodegeneration and cognitive decline, negatively impacting diabetics' self-control and life quality.

Objective: To assess cognitive function in people with type 2 diabetes and to assess how it relates to glycemic control, diabetes duration, BMI, and selected lifestyle and characteristics of the population.

Methods: This observational, cross-sectional investigation was carried out at Teerthanker Mahaveer Hospital, Uttar Pradesh, over a period of six months. A total of 449 consenting adults aged 30–70 years with diagnosed T2DM were enrolled. Exclusion criteria included neurological illness, psychiatric medication use, and sensory impairments. To evaluate cognitive status, the Mini-Mental status Examination (MMSE). Glycemic control was evaluated by HbA1c, postprandial blood glucose (PPBG), and fasting blood glucose (FBG) measurements. BMI and diabetes duration were recorded. Data were analyzed using SPSS v25.0; Spearman correlation and non-parametric tests were applied.

Results: Cognitive impairment and inadequate glycemic management were strongly correlated (HbA1c >6.5%, $p = 3.4E-07$), longer diabetes duration ($p = 0.0048$), and higher BMI ($p < 0.0001$). Participants with elevated FBG and PPBG also showed higher prevalence of mild to severe cognitive impairment. While trends were observed regarding education, gender, and lifestyle factors, these were not statistically significant.

Conclusion: Cognitive decline is common among T2DM patients and correlates strongly with glycemic parameters and disease duration. Regular cognitive testing ought to be incorporated into diabetic care, particularly for long-standing or poorly controlled patients. Early detection and intervention could improve patient results and lessen. The enduring effects of cognitive impairment brought on by diabetes.

Keywords: *Mini-Mental State Examination (MMSE), Type 2 Diabetes Mellitus, Cognitive Impairment, Glycemic Control, HbA1c, Postprandial blood sugar, fasting blood sugar, Diabetes Duration.*

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1. INTRODUCTION

Diabetes mellitus (DM) is a long-term metabolic disorder marked by elevated blood sugar levels brought on by either insufficient insulin or production or insulin resistance. Among its well-established complications are microvascular (neurological, nephrotic, and retinopathic) and macrovascular (cardiovascular and peripheral vascular diseases) consequences, which significantly contribute to long-term morbidity and mortality. However, cognitive dysfunction particularly When someone has Type 2 Diabetes Mellitus (T2DM), it's an underrecognized complication that is gaining increasing attention in recent years.[1]

Emerging evidence suggests that T2DM adversely affects cognitive skills like executive function and memory, processing speed, and focus. Mechanisms including oxidative damage, inflammation, insulin resistance, and persistent hyperglycemia are thought to be involved in this advanced glycation end-product accumulation, and cerebrovascular damage. Disruption in insulin and The brain's insulin-like growth factor (IGF) signaling has been associated with neurodegeneration, resembling pathophysiological patterns moderate Cognitive impairment and Alzheimer's disease (MCI and AD).[2,3]

Type 2 diabetics are significantly more likely to develop dementia and MCI, according to several research. The risk appears to be more pronounced in elderly people and those who have had diabetes for a longer period of time.[4] Specific cognitive domains affected in T2DM include psychomotor speed, verbal memory, executive functioning, and visuospatial skills.[5] Additionally, metabolic syndrome, obesity, hypertension, and dyslipidemia common in T2DM may further aggravate cognitive decline.[6]

Despite growing awareness, cognitive assessment is not routinely performed in clinical diabetes care, especially in low-resource settings. This neglect can lead to reduced treatment adherence, diminished quality of life, increased dependency, and higher health care costs.[7] Identifying cognitive impairment early in the diabetic population is critical for implementing targeted interventions such as lifestyle modification, cognitive training, glycemic control, and pharmacologic strategies to delay progression.[8]

Moreover, certain modifiable and non-modifiable factors including age, education, vascular comorbidities, depression, physical inactivity, and nutritional deficiencies may influence cognitive performance in T2DM individuals.[9] Thus, a holistic and multidisciplinary approach is warranted for optimal diabetes management that also considers cognitive health.[10]

Given the growing burden of diabetes worldwide and the aging population, it is imperative to find out how common and severe cognitive impairment is in people with type 2 diabetes, especially in tertiary healthcare centers where diverse patient populations can be studied. The purpose of this study is to assess the cognitive profiles of people with Type 2 diabetes and investigate risk factors related to the condition. thereby aiding in early recognition and comprehensive diabetes care.

2. MATERIALS AND METHODS

During the course of six months, Teerthanker Mahaveer Hospital and Research Centre, District Moradabad, Uttar Pradesh, undertook this cross-sectional, observational prevalence study. Patients who were enrolled in the hospital's outpatient (OPD) and inpatient (IPD) departments and had a verified diagnosis of Type 2 Diabetes Mellitus (T2DM) participated in the study. A total of 449 individuals were enrolled in the study using a time-bound sampling technique. Participation was voluntary, and Before being included, all eligible individuals provided written informed permission.

Those with Type 2 diabetes made up the study population who were between the ages of 30 and 70. who were willing to undergo cognitive and clinical assessments. Individuals with known auditory, visual, or speech impairments; those on antidepressants, antipsychotics, or sedative medications; and those diagnosed with neuromuscular disorders, epilepsy, cerebrovascular accidents, or recent head injury were excluded. Additionally, patients with localized upper limb injuries, those experiencing diabetic emergencies, and those who declined to participate were also excluded to ensure accurate and reliable assessment of cognitive function.

For every participant, demographic information such as age, gender, occupation, and educational attainment was documented. Detailed clinical histories were obtained to evaluate lifestyle factors, duration of diabetes, and medication usage. A comprehensive general and systemic examination was conducted for each subject, paying special attention to the respiratory, cardiovascular, and central neural systems (CVS, RS, and CNS), and abdominal findings. Vital indicators including heart rate and blood pressure were recorded to identify any underlying hemodynamic instability.

Body mass index, weight, and height are anthropometric measurements used to evaluate physical health were taken, as obesity and metabolic syndrome are known contributors to cognitive decline in diabetic individuals. A standardized and validated instrument commonly Cognitive performance was measured using the Mini-Mental State Examination (MMSE), This used as a cognitive impairment screening tool. Cognitive state was categorized using the MMSE scores as normal, mildly impaired, moderately impaired, or severely impaired.

Glycemic control was evaluated through laboratory investigations including Blood glucose levels during fasting (FBG), postprandial (PPBG), and glycated hemoglobin (HbA1c) values. These parameters provided insight into the chronic glycemic status of the participants and helped in establishing potential correlations between hyperglycemia and cognitive decline. All data were securely documented and prepared for statistical analysis to find out how common cognitive impairment is in people with Type 2 diabetes and to explore relevant clinical and biochemical associations.

During the study period, a larger sample size of 449 individuals was chosen to account for any dropouts, non-responses, or incomplete data. This enhanced the findings' dependability and guaranteed sufficient statistical power.

3. STATISTICAL ANALYSIS

Microsoft Excel was used to enter the data, and SPSS version 25.0 was used for analysis. Clinical and demographic characteristics were summarized using descriptive statistics. To evaluate the connection between glycemic state and cognitive scores, Spearman's correlation was used. U tests were used to compare the Kruskal-Wallis and Mann-Whitney groupsP-values were deemed statistically significant if they were less than the significance level of 0.05.

4. RESULTS

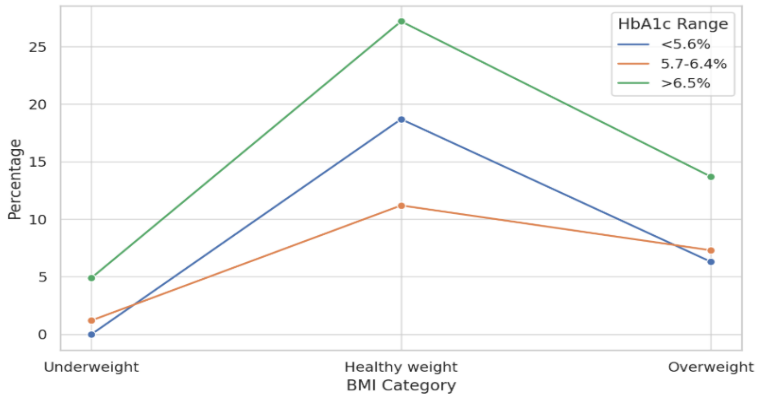
The Mini-Mental State Examination (MMSE) was used to evaluate the cognitive function of 449 people with Type 2 Diabetes Mellitus (T2DM), ages 30 to 70. The results were analyzed in relation to demographic factors, glycemic indices, lifestyle behaviors, BMI, and diabetes duration.

The participants were split into two age groups: those aged 51–70 and those aged 30–50. A rising trend in HbA1c values was observed with advancing age; 21.3% of those in the younger group had HbA1c >6.5%, while this increased to 28.7% in the older group. Although the difference was not statistically significant ($p = 0.317$), this suggests worsening glycemic control with age, which may increase cognitive risk (Table 1).

Table 1. HbA1c Levels by Age Group

Age Group	HbA1c <5.6%	HbA1c 5.7–6.4%	HbA1c >6.5%
30–50 years	16.50%	7.60%	21.26%
51–70 years	8.50%	17.40%	28.74%

Body Mass Index (BMI) showed a strong association with glycemic control. Overweight individuals had the highest percentage (13.7%) of HbA1c >6.5%, followed by those with normal weight (27.2%), while underweight individuals had the lowest prevalence (4.9%). This trend was statistically significant ($p < 0.0001$), confirming obesity as a major risk factor for glycemic dysregulation.



MMSE scores revealed a significant association with glycemic status. Among individuals with HbA1c >6.5%, 22.3% showed mild cognitive impairment and 9.8% had severe impairment. Conversely, only 8% of those with HbA1c <5.6% showed any cognitive decline. This association was statistically significant ($p = 3.4E\text{-}07$), suggesting that poor long-term glycemic control negatively impacts cognitive function (Table 2, Figure 2).

Table 2. MMSE Scores by HbA1c Range

MMSE Status	**HbA1c <5.6%**	**HbA1c 5.7–6.4%**	**HbA1c >6.5%**
Normal	14.48%	5.79%	18.04%
Mild Impairment	8.02%	11.13%	22.27%
Severe Impairment	2.45%	8.02%	9.80%

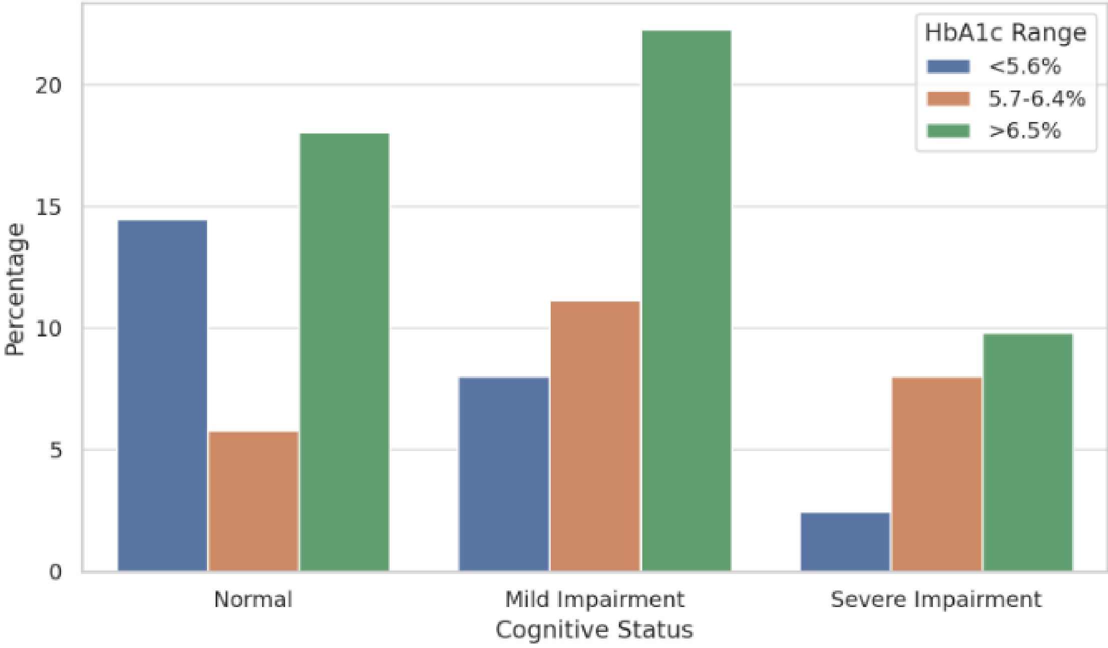


Figure 2. Cognitive Impairment Across HbA1c Levels

Further analysis demonstrated that both short-term glycemic indices Additionally, there was a substantial correlation between cognitive impairment and both postprandial blood sugar (PPBS) and fasting blood sugar (FBS). For instance, compared to people with normal FBS, those with FBS >126 mg/dL were more likely to have mild impairment (20.2%) and severe impairment (8.7%). A similar pattern was observed for PPBS, with those having levels >200 mg/dL exhibiting the highest cognitive impairment (Table 3). These results underscore the role of both chronic and acute hyperglycemia in cognitive deterioration.

MMSE Status	**FBS <100**	**FBS 100–125**	**FBS >126**	**PPBS <140**	**PPBS 141–199**	**PPBS >200**
Normal	14.2	11.6	15.3	13.4	12.7	14.4
Mild Impairment	8.1	14.5	20.2	7.8	13.4	21
Severe Impairment	2.7	4.7	8.7	3.1	4.2	10

The duration of diabetes significantly influenced cognitive outcomes. Participants with a diabetes history of more than 10 years showed the highest levels of both mild and severe cognitive impairment (8.0% and 11.1%, respectively). In contrast, individuals with less than 1 year of diabetes had comparatively better MMSE scores. This relationship was statistically significant ($p = 0.0048$), indicating a cumulative neurodegenerative effect of long-term hyperglycemia (Table 4, Figure 3).

Table 4. MMSE Scores by Duration of Diabetes

Duration of Diabetes	**Normal (%)**	**Mild Impairment (%)**	**Severe Impairment (%)**
<1 year	5.3	9.3	4.9
2–4 years	8.2	7.7	4.7
5–7 years	6	4.7	4.2
8–10 years	5.6	4.7	7.1
>10 years	8.5	8	11.1

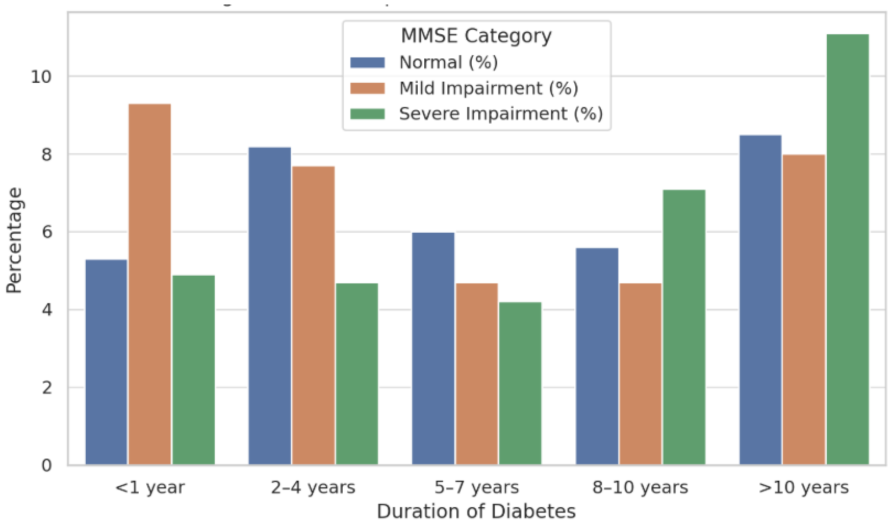


Figure 3. MMSE Impairment Across Duration of Diabetes

Lifestyle factors such as physical inactivity, mixed diet, and alcohol abstinence showed associations with poorer glycemic control and higher rates of cognitive decline. However, these trends were not statistically significant and hence are not included in graphical representation to maintain focus and simplicity. Still, they underline the importance of behavioral modifications in diabetes management.

5. DISCUSSION

This cross-sectional study assessed cognitive function in individuals with The Mini-Mental State Examination (MMSE) was used to assess type 2 diabetes mellitus (T2DM) and its correlation with body mass index (BMI), diabetes duration, glycemic indices, and other lifestyle factors. According to the results, T2DM is substantially linked to cognitive impairment, particularly in patients with greater illness duration and inadequate glycemic control.

A major finding of this study was the statistically significant association between elevated HbA1c levels and declining MMSE scores. Participants with HbA1c >6.5% had higher rates of both mild (22.3%) and severe (9.8%) cognitive impairment, compared to those with normal glycemic levels. These results are in line with those of Biessels et al., who found that those with The risk of dementia is 1.5–2 times higher in people with diabetes. than people without the disease.[11] The ACCORD-MIND trial further demonstrated that higher HbA1c was associated with greater cognitive decline and smaller brain volumes over time in T2DM patients.[12]

Our findings are supported by Cukierman et al., who showed that poor glycemic control accelerates age-related cognitive decline by impairing both executive function and memory.[13] Palta et al. confirmed that elevated HbA1c was associated with brain atrophy and delayed processing speed.[14] The pathophysiology behind this is multifactorial, involving insulin resistance within the brain Chronic low-grade inflammation, oxidative stress, and advanced glycation end products (AGEs).[15,16]

Duration of diabetes furthermore possessed a statistically significant correlation with cognitive outcomes in our study. Participants with more than 10 years of diabetes showed the highest rates of severe MMSE impairment (11.1%). Kodl and Seaquist proposed that prolonged hyperglycemia leads to cumulative neurovascular damage, causing cerebral small vessel disease and neurodegeneration[15]. Dybjer et al. corroborated this, noting that higher HbA1c and longer diabetes duration predicted cognitive and functional decline.[16]

Body mass index (BMI) was another key factor in our analysis. Obese individuals exhibited the highest HbA1c levels and were more likely to exhibit cognitive decline. This is in line with studies by Yaffe et al. and Kim et al., both of which found that midlife obesity significantly increases the risk of dementia due to insulin resistance and inflammatory mediators affecting brain health.[17,18]

Interestingly, levels of postprandial blood sugar (PPBS) and fasting blood sugar (FBS) both shown notable associations with cognitive impairment in our cohort. These findings align with van den Berg et al., who emphasized that postprandial glycemic excursions may be even more neurotoxic than fasting hyperglycemia[19].

Our results also resonate with findings from Indian studies. Tripathi et al. observed that nearly one-third of T2DM patients in North India had cognitive impairment based on MMSE and MoCA, with duration of illness and HbA1c being key predictors.[20] Nasreddine et al. introduced the MoCA as a more sensitive tool for early cognitive decline, but MMSE remains widely used in resource-limited settings due to its simplicity and acceptability.[21]

Although not statistically significant in our study, lower education and male gender were linked to poorer glycemic and cognitive profiles. Cheng et al. demonstrated that lower education levels amplify the risk of cognitive decline in diabetics due to limited health literacy and poorer disease management.[22] Similarly, Lyall et al., in the UK Biobank study, reported gender-based differences in cognitive trajectories among T2DM patients.[23]

Lifestyle influences were present though not statistically significant. Participants with sedentary habits and mixed diets had higher HbA1c and lower MMSE scores. A meta-analysis by Zhang et al. found that adherence to the Mediterranean diet significantly improved cognitive function in diabetic populations.[24] Baker et al. also demonstrated that aerobic exercise can enhance Memory and executive function in elderly individuals with glucose intolerance.[25]

This study's strength lies in its comprehensive evaluation of cognitive impairment using MMSE alongside biochemical and demographic markers in a real-world tertiary care setting. However, causality inference is limited by its cross-sectional nature and the absence of neuroimaging or advanced cognitive tools like MoCA may underestimate subtle deficits.

6. CONCLUSION

This study unequivocally connects Type 2 Diabetes Mellitus to cognitive decline, particularly in individuals who are obese, have poor glycemic control, and have had the condition for a long time. The neurocognitive effects of chronic hyperglycemia are highlighted by the strong association between lower MMSE scores and higher HbA1c levels. Furthermore, BMI, postprandial and fasting glucose levels, and duration of diabetes, emerged as important predictors of cognitive decline. While lifestyle factors and educational status showed nonsignificant trends, they warrant further exploration. Regular cognitive assessment should be included in diabetes management regimens due to the rising incidence of diabetes and associated consequences, especially in tertiary healthcare settings. Early detection of cognitive impairment can facilitate targeted interventions, optimize diabetes management, and improve patients' quality of life. Future longitudinal studies integrating neuroimaging and comprehensive cognitive assessments are required to further define underlying mechanisms and validate causation.

REFERENCE

[1] Pelimanni E, Jehkonen M. Type 2 Diabetes and Cognitive Functions in Middle Age: A Meta-Analysis. *Journal of the International Neuropsychological Society*. 2019;25(2):215-229. doi:10.1017/S1355617718001042

[2] Sebastian MJ, Khan SK, Pappachan JM, Jeeyavudeen MS. Diabetes and cognitive function: An evidence-based current perspective. *World J Diabetes*. 2023;14(2):92-109. doi:10.4239/wjd.v14.i2.92

[3] Aderinto N, Olatunji G, Abdulbasit M, et al. The impact of diabetes in cognitive impairment: A review of current evidence and prospects for future investigations. *Medicine*. 2023;102(43):e35557. doi:10.1097/MD.0000000000035557

[4] Cholerton B, Baker LD, Montine TJ, Craft S. Type 2 Diabetes, Cognition, and Dementia in Older Adults: Toward a Precision Health Approach. *Diabetes Spectr*. 2016;29(4):210-219. doi:10.2337/ds16-0041

[5] Moheet A, Mangia S, Seaquist ER. Impact of diabetes on cognitive function and brain structure. *Ann N Y Acad Sci*. 2015;1353:60-71. doi:10.1111/nyas.12807

[6] Carlsson CM. Type 2 diabetes mellitus, dyslipidemia, and Alzheimer's disease. *J Alzheimers Dis*. 2010;20(3):711-722. doi:10.3233/JAD-2010-100012

[7] Munshi M, Grande L, Hayes M, et al. Cognitive Dysfunction Is Associated With Poor Diabetes Control in Older Adults. *Diabetes Care*. 2006;29(8):1794-1799. doi:10.2337/dc06-0506

[8] Cukierman-Yaffe T, Gerstein HC, Williamson JD, et al. Relationship Between Baseline Glycemic Control and Cognitive Function in Individuals With Type 2 Diabetes and Other Cardiovascular Risk Factors. *Diabetes Care*. 2009;32(2):221-226. doi:10.2337/dc08-1153

[9] de Almeida Faria ACR, Dall'Agnol JF, Gouveia AM, de Paiva CI, Segalla VC, Baena CP. Risk factors for cognitive decline in type 2 diabetes mellitus patients in Brazil: a prospective observational study. *Diabetol Metab Syndr*. 2022;14(1):105. doi:10.1186/s13098-022-00872-3

[10] Makoni L, Manduna IT, Mbiriri AL. A review of whole-medical systems and holistic care approach for type 2 diabetes and associated metabolic syndrome. *J Integr Med*. 2024;22(3):199-209. doi:10.1016/j.joim.2024.04.001

[11] Biessels GJ, Staekenborg S, Brunner E, Brayne C, Scheltens P. Risk of dementia in diabetes mellitus: a systematic review. *Lancet Neurol*. 2006;5(1):64-74. doi:10.1016/S1474-4422(05)70284-2

[12] Launer LJ, Miller ME, Williamson JD, et al. Effects of intensive glucose lowering on brain structure and function in people with type 2 diabetes (ACCORD MIND): a randomised open-label substudy. *Lancet Neurol*.

2011;10(11):969-977. doi:10.1016/S1474-4422(11)70188-0

[13] Cukierman T, Gerstein HC, Williamson JD. Cognitive decline and dementia in diabetes—systematic overview of prospective observational studies. *Diabetologia*. 2005;48(12):2460-2469. doi:10.1007/s00125-005-0023-4

[14] Palta P, Schneider ALC, Biessels GJ, Touradji P, Hill-Briggs F. Magnitude of Cognitive Dysfunction in Adults with Type 2 Diabetes: A Meta-analysis of Six Cognitive Domains and the Most Frequently Reported Neuropsychological Tests Within Domains. *Journal of the International Neuropsychological Society*. 2014;20(3):278-291. doi:10.1017/S1355617713001483

[15] Kodl CT, Seaquist ER. Cognitive Dysfunction and Diabetes Mellitus. *Endocr Rev*. 2008;29(4):494-511. doi:10.1210/er.2007-0034

[16] Dybdal D, Tolstrup JS, Sildorf SM, et al. Increasing risk of psychiatric morbidity after childhood onset type 1 diabetes: a population-based cohort study. *Diabetologia*. 2018;61(4):831-838. doi:10.1007/s00125-017-4517-7

[17] Yaffe K, Weston AL, Blackwell T, Krueger KA. The Metabolic Syndrome and Development of Cognitive Impairment Among Older Women. *Arch Neurol*. 2009;66(3). doi:10.1001/archneurol.2008.566

[18] Kim S, Kim Y, Park SM. Body Mass Index and Decline of Cognitive Function. *PLoS One*. 2016;11(2):e0148908. doi:10.1371/journal.pone.0148908

[19] Reijmer YD, van den Berg E, Ruis C, Jaap Kappelle L, Biessels GJ. Cognitive dysfunction in patients with type 2 diabetes. *Diabetes Metab Res Rev*. 2010;26(7):507-519. doi:10.1002/dmrr.1112

[20] Yerrapragada DB, Rao CR, Karunakaran K, Lee HSE. Cognitive Dysfunction Among Adults With Type 2 Diabetes Mellitus in Karnataka, India. *Ochsner Journal*. 2019;19(3):227-234. doi:10.31486/toj.18.0160

[21] Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment, MoCA: A Brief Screening Tool For Mild Cognitive Impairment. *J Am Geriatr Soc*. 2005;53(4):695-699. doi:10.1111/j.1532-5415.2005.53221.x

[22] Cheng G, Huang C, Deng H, Wang H. Diabetes as a risk factor for dementia and mild cognitive impairment: a meta-analysis of longitudinal studies. *Intern Med J*. 2012;42(5):484-491. doi:10.1111/j.1445-5994.2012.02758.x

[23] Lyall DM, Celis-Morales CA, Anderson J, et al. Associations between single and multiple cardiometabolic diseases and cognitive abilities in 474 129 UK Biobank participants. *Eur Heart J*. 2017;38(8):577-583. doi:10.1093/eurheartj/ehw528

[24] Zheng X, Zhang W, Wan X, et al. The effects of Mediterranean diet on cardiovascular risk factors, glycemic control and weight loss in patients with type 2 diabetes: a meta-analysis. *BMC Nutr*. 2024;10(1):59. doi:10.1186/s40795-024-00836-y

[25] Baker LD, Frank LL, Foster-Schubert K, et al. Effects of Aerobic Exercise on Mild Cognitive Impairment. *Arch Neurol*. 2010;67(1). doi:10.1001/archneurol.2009.307