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RESEARCH ARTICLE

A study to assess the relationship between cognitive impairment and glycemic management in patients with type 2 diabetes using MoCA score

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ABSTRACT

Background: Later in life, people with diabetes mellitus 2 experience cognitive impairment, which lowers their quality of life. There is little local literature on cognitive diseases, particularly mild cognitive impairment (MCI), despite mounting evidence of these conditions.

Materials and Methods: We used the Montreal Cognitive Assessment (MoCA) test to determine the prevalence of mild cognitive impairment (MCI), which was previously unknown, in type 2 diabetic patients who were visiting a tertiary care centre. We also looked at the relationships between the MoCA scores and HbA1c, fasting blood sugar (FBS), postprandial blood sugar (PPBS), age, and length of diabetes. The study comprised seventy individuals with type 2 diabetes mellitus. Normal cognition (NC) was defined as patients with MoCA scores ≥26, while MCI was defined as those with scores <26.

Results: While 55% of individuals with type 2 diabetes mellitus had MCI (MoCA score <26), 50 or 45% of those patients had normal cognitive function (MoCA score ≥26). Patients with mild cognitive impairment had significantly higher fasting, PPBS, and HbA1c levels. The groups' mean ages and the length of time they had diabetes did not differ significantly. The MoCA scores were negatively correlated with the levels of HbA1c, FBS, and 2hr PPBS

Conclusion: According to the study's findings, individuals with type 2 diabetes are very susceptible to mild cognitive impairment. There was a negative correlation between the MoCA score and HbA1c, higher disease duration, and fasting blood sugar levels.

Keywords: Diabetes, Cognitive impairment, Dementia, MoCA

Introduction

Diabetes mellitus is one of the most difficult health issues of the twenty-first century. One of the six nations that make up South East Asia is India. 82 million of the 425 million people with diabetes worldwide reside in this region, and by 2045, that number is expected to increase to 151 million[1]. The prevalence of diabetes mellitus has been rising worldwide, which has increased the disease's morbidity. Although diabetic patients are regularly evaluated for diabetic retinopathy, neuropathy, and nephropathy, the cognitive impairment linked to diabetes is frequently disregarded[2]. Neurocognitive problems can result from cognitive impairment, which can worsen the effects of diabetes on a person's health. The prevalence of cognitive impairment in diabetic individuals is expected to rise in tandem with the disease's rising prevalence. As a result, regular cognitive decline screening ought to be taken into account when managing diabetes.

Few studies have shown diabetes to be a risk factor for dementia, despite the fact that the effects of diabetes mellitus on the retina, kidneys, heart, and peripheral nerve systems are well known[2]. A group of higher brain functions, such as memory, language, executive function, attention, perception, and social behaviour, are collectively referred to as cognition. Diabetes and dementia are likely to have a complicated and multifaceted interaction[3]. Although the precise pathophysiology of cognitive dysfunction in diabetes is not fully known, it is believed that vascular disease, insulin resistance, hypoglycemia and hyperglycemia all play important roles[4]. To create prevention and treatment plans, further research is required to comprehend the processes and natural history of this issue. According to reports, those who have Type 2 diabetes (T2D) are twice as likely to acquire dementia as those who do not[5].

According to a more recent meta-analysis by Cheng et al., individuals with diabetes had a 1.5-fold increased risk of Alzheimer's disease-related dementia and a 2.5-fold increased risk of vascular dementia [3]. Furthermore, it has been discovered that pre-diabetes and diabetes mellitus both quicken the rate at which mild cognitive impairment turns into full dementia[6]. Furthermore, compared to people with diabetes alone, patients with Type 2 diabetes and cognitive impairment (CI) are less likely to obtain proper diabetic care[7].

Depending on how long it takes to identify the issue, cognitive impairment can range from mild to severe dementia. Dealing with this more effectively may be possible if cognitive decline in individuals that were previously undiagnosed is identified early. Researchers have employed a variety of instruments to evaluate cognitive function over the years, including the Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Hopkins verbal learning test, Addenbrooke's cognitive examination-revised, clock-drawing test, six-item cognitive impairment test, and others[8]. The Mini-Mental Status Examination (MMSE) was thought to be the greatest screening tool for cognitive impairment for the previous thirty years, but in a clinical environment, other sensitive tests are also needed to identify moderate cognitive impairment[9,10]. Other evaluation tools have also been developed for this purpose in order to evaluate moderate cognitive impairment[11]. The Montreal Cognitive Assessment (MoCA), one of these assessments, has been shown to evaluate MCI; however, it has not yet been validated for use with T2D patients[12].

Very few studies have been done domestically and abroad to examine the efficacy of screening techniques like MoCA for this purpose, despite recent literature emphasizing the significance of early screening for cognitive impairment in T2D patients. Thus, the purpose of this study is to use the MoCA score to examine the relationship between cognitive impairment and glycemic management in T2D patients.

Materials and Methods:

Finding the prevalence of cognitive impairment in patients with type 2 diabetes mellitus aged 35–65 who visit the endocrinology outpatient department at a tertiary care facility was our primary goal. The secondary goals were to determine whether blood glucose levels and MoCA scores were correlated, as well as whether HbA1c levels, the length of diabetes, and cognitive impairment were related.

We used a cross-sectional study design. The minimal sample size was 66, based on the prevalence rate reported in a previous paper, with

a 95% confidence level and a 20% allowed error. We recruited 110 patients with type 2 diabetes mellitus who were enrolled in an outpatient endocrinology department at a tertiary care hospital and ranged in age from 35 to 65. The study excluded individuals with acute sickness, psychological disorders, epilepsy, Alzheimer's disease (AD), stroke, illiteracy, severe hearing or vision impairment, and those who were unable of giving their consent. We chose to employ MoCA for the study since it is a cognitive screening test that has a good sensitivity and specificity for identifying mild cognitive impairment. We took the MoCA test in English as well as translated in local language i,e. in bengali as prepared with help of intigent research, which has a 30-point rating system. On the day of the MoCA test, the most recent HbA1c, fasting blood sugar (FBS), and 2hr postprandial blood sugar (PPBS) readings were extracted from the electronic medical records. Normal cognition (NC) was defined as patients with MoCA scores ≥26, while MCI was defined as those with scores <26.

Statistical analysis:

Software called SPSS version was used to do the statistical analysis. For the continuous variables, means and standard deviations were computed, while for the categorical variables, counts and percentages were determined. Frequency and percentage were computed to assess the prevalence of cognitive impairment in people with type 2 diabetes mellitus. The Chi-square test was used to determine whether the relationship between category variables and cognitive impairment was statistically significant.

Results:

This study had 110 patients in total. The mean age of the patients was 55.71±5.02 years, with 89 or 81% males and 21 or 19% females. The average fasting blood sugar level was 197.62±35.76, the average postprandial blood sugar level was 261.83 ± 38.29, and the average HbA1c score was 8.23±1.2. All patients had an average illness duration of 11.8±5.9 years.

Table 1: Baseline Descriptive statistics of the 110 type 2 diabetic patients that were part of the study

Variables	Study Participants (N=110)
Age (Years)	55.71±5.02
Gender (M/F)(N)	89/21
BMI (Kg/m2)	26.71±4.32
Duration of Diabetes (Years)	11.8±5.9
HbA1c (%)	8.23±1.2
Fasting blood sugar (mg/dl)	197.62±35.76
Postprandial blood sugar (mg/dl)	261.83 ± 38.29
MoCA	25.41±2.62
History of Depression	31(28%)
History of Stroke	12(11%)
History of Cardiovascular Disease	45(41%)

Table 2 lists the overall MoCA score as well as the performance scores in each cognitive subdomain.

Table 2: Mean of subdomain and total MoCA score.

Cognitive domain	Maximum score	Mean ± SD
Visuospatial/Executive function	5	2.37 ± 0.17
Naming	3	2.54 ± 0.09
Attention	6	4.86 ± 0.17
Language	3	1.78 ± 0.09
Abstraction	2	1.03 ± 0.11
Delayed recall	5	1.10 ± 0.17
Orientation	6	5.82 ± 0.12
Total score	30	25.41±2.62

In this study, 50 or 45% patients with type 2 diabetes mellitus had normal cognitive function (MoCA score ≥26), while 60 or 55% patients had MCI (MoCA score <26). Patients with MCI had significantly higher fasting,2hr PPBS, and HbA1c levels [Table 3]. The groups' mean ages and the length of time they had diabetes did not differ significantly. The MoCA scores were negatively correlated with the levels of HbA1c, FBS, and 2hr PPBS [Table 4].

Table 3: Means and P values of various variables are compared between people with mild cognitive impairment and people with normal cognition.

Variable	MCI (N=60)	NC (N=50)	P Value
Age	53.91±5.94	52.50±8.37	0.078
HbA1c	8.64±1.72	7.67±1.56	0.021
FBS	174.06±66.71	148.25±53.64	0.029
PPBS	286.04±86.64	215.61±83.41	0.001
Duration of Diabetes	12.64±6.31	11.03±5.52	0.412

Table 4: Comparison of duration (years), fasting and postprandial blood sugar levels, HbA1c, and age (years)

Variables	MoCA Score		
	Pearson correlation coefficient	P Value	n
HbA1c	−0.294	0.017	110
FBS	−0.317	0.008	110
PPBS	−0.412	0.001	110
Duration of Diabetes	−0.139	0.238	110

Discussion:

Given the possibility of associated morbidities and the consequences that arise from or in conjunction with its chronic status, diabetes mellitus is a serious public health concern. Recent research has shown that T2D patients, especially the elderly, have cognitive abnormalities[13]. Alzheimer's disease, vascular dementia, mild to severe dementia, and loss of verbal or functional memory are among the cognitive illnesses that are frequently documented. Despite the fact that there are several possible reasons of cognitive issues, glycemic control has lately been identified as the most prevalent[14,15]. This study was planned because, despite the rising frequency of MCI in T2D patients, there is a dearth of local literature on the subject[16,17].

The study included 21 or 19% female patients and 89 or 81% male patients, with a mean age of 55.71±5.02 years. The average length of illness for the patients was 8.98 ± 4.27 years. Cognitive impairment was more likely to develop in older female patients with lower sociodemographic status, extended duration of diabetes mellitus, and low educational attainment. According to a different study, 98 or 50.5% of the 194 diabetic participants who were interviewed had cognitive impairment. Female participants which was 53.6% outnumbered male participants i.e. 46.4%, and over half of the subjects i.e. 56.2% were ≥ 65 years of age[18]. Sixty-four percent of the individuals had diabetes for less than ten years.

FBS,2hr PPBS, and HbA1c were significantly higher in our study's cognitively impaired individuals, and these values exhibited a negative correlation with MoCA scores. According to a research by Roy et al., 30.2% of patients with HbA1c 7% or higher and 11.6% of patients with optimum glycemic management (HbA1c <7%) experienced cognitive impairment[19]. According to Khullar et al., those with blood glucose levels greater than 125 mg/dl were 1.73 times more likely to experience neurocognitive impairment[20,21]. A statistically significant age-adjusted correlation between HbA1c level and scores on four cognitive tests was reported in the ACCORD-MIND experiment, which involved 2977 individuals with type 2 diabetes[22]. There is evidence of an inverse relationship between HbA1c and the clock-drawing and clock-in-a-box tests[23]. Our findings thus support the body of research showing a link between cognitive deterioration and poor glycemic control in type 2 diabetes.

It is unclear if better glucose control results in better cognition, despite the large body of epidemiologic evidence connecting low blood sugar and cognitive impairment. Improved HbA1c was linked to improved cognition in nonamnestic areas, according to the diabetes control and complications trial in type 1 diabetes[24]. According to Luchsinger et al., lowering HbA1c levels during a five-year period in a senior population was linked to a halt in the rate of global cognitive impairment[25]. One of the main causes of neurodegeneration is insulin dysregulation. Higher levels of Aβ protein in the brain are linked to elevated serum insulin levels, which can lead to senile plaques, neurofibrillary tangles, and a decline in cognitive function. Diabetes-related elevated inflammatory cytokine levels exacerbate cognitive impairment.

The MoCA, which is freely accessible and comes in numerous editions in different languages, is currently recognized as a great instrument for quick cognitive screening. Using a cutoff score of 26, the first MoCA demonstrated a sensitivity of 100% and a specificity of 87% in identifying moderate AD[26]. It is believed that amnestic mild cognitive impairment (aMCI) has a high chance of developing into AD. Prior research has demonstrated that the MoCA's overall score was a more effective discriminator for aMCI and that it could distinguish between healthy controls and patients with nonamnestic mild cognitive impairment (naMCI) with a moderate degree of accuracy[27]. Therefore, the variations shown in our study's MoCA scores may indicate a future risk of developing AD.

In conclusion, our research indicates that a significant number of patients with type 2 diabetes mellitus who visit an outpatient clinic have unrecognized mild cognitive impairment. All glycemic control indicators and MoCA scores, which are indicative of cognitive function, showed a significant negative connection. These findings strongly support routine screening for mild cognitive impairment in patients with type 2 diabetes mellitus using a sensitive test like MoCA. Future research on the advantages of better glycemic control on cognitive function would be necessary to fully comprehend the importance of our findings for the long-term care of these patients.

There are significant drawbacks to the current study, including the relatively small sample size; higher sample sizes are thought to yield more trustworthy results. The study sample was selected from a single center, which would have limited the findings' applicability to other populations. Additionally, the use of self-reported data for some factors might have resulted in reporting bias. Furthermore, the study's findings cannot be applied to illiterate patients because it only included literate diabetic patients; therefore, future research should look at evaluating cognitive function in illiterate diabetic patients as well.

Conclusion:

Our research highlights the importance of a robust association between T2D and cognitive performance. According to the study's findings, individuals with type 2 diabetes are very susceptible to mild cognitive impairment. There was a negative correlation between the MoCA score and HbA1c, higher disease duration, and fasting blood sugar levels.

Data availability statement:

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

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Author contributions

Author 1: Conceptualization; Formal analysis; Methodology; Writing—original draft; data collection. **Author 2:** Conceptualization; Formal analysis; Methodology; Writing—original draft; data collection. **Author 3**: Data collection and statistical analysis

Conflict of Interest:

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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