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Prevalence of Cognitive Impairment among Type 2 Diabetes Mellitus Patients Attending Family Medicine Clinic in Suez Canal University Hospital

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Abstract

Background: **Dementia risk is increased by 50% in people with type 2 diabetes mellitus (T2DM). The gradual loss of most cognitive functions leads to increased dependency and social isolation.** ***Aim*****: This study aimed to assess the prevalence of cognitive impairment among T2DM patients compared to non-diabetic patients and to determine the associated factors that increase the risk of cognitive impairment among T2DM patients.** ***Subjects and Methods:*** **A comparative cross-sectional study was conducted at the family medicine outpatient clinic, Suez Canal University Hospital, Egypt, between October 2019 and October 2020. A simple random sampling of 400 participants was categorized into two groups, T2DM patients (200) and non-diabetic patients (200). The Mini Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) tools were used to assess the cognitive function.** ***Results:*** **The prevalence of cognitive impairment was 50% in diabetic patients as measured by MoCA, compared to 26.5 % in the non-diabetic group (P <0.05). In specific cognitive domains (orientation, calculation, recall, and language), diabetic patients showed significantly lower scores compared with non-diabetic patients (P <0.05). Education and socioeconomic status were significant positive predictors of MMSE score; while age, BMI, duration of diabetes, FBG, HbA1c, and LDL were negative predictors of cognitive impairment tested by MMSE among T2DM patients (p<0.05).** ***Conclusion:*** **Diabetic patients were more likely to have cognitive impairment compared to patients without diabetes. Diabetes had a particularly negative impact on the following cognitive functions: orientation, calculation, recall, and language.**

Keywords: Type 2 diabetes mellitus, cognitive impairment, prevalence, dementia

Introduction

According to the International Diabetes Federation, 8.8% of individuals aged 20 to 79 years worldwide had diabetes in 2017, with 79% of them living in low- and middle-income countries. In terms of the top ten countries for the number of diabetics, Egypt was rated eighth in 2017 and is expected to be sixth in 2045[1]. Previous studies have implicated that in the elderly; type 2 diabetes mellitus (T2DM) is a risk factor for cognitive decline and dementia[2]. Compared to individuals without diabetes, diabetes in midlife is associated with a 19 % greater cognitive dysfunction over 20 years[3]. Mild cognitive impairment (MCI) is an intermediate stage between normal

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Cognitive function and dementia, and it is more common in T2DM patients over the age of 65[2]. In Egypt, the prevalence of MCI among patients with T2DM was significantly higher (34%) when compared to non-diabetics (13%)[3]. Moreover, T2DM is considered a significant risk factor for not only vascular dementia but also Alzheimer's disease (AD). Smoking and obesity are considered risk factors for both vascular and non-vascular dementias as well[4]. In T2DM patients, the hyperglycemic status leads to chronic damage and dysfunction of blood vessels, the brain, nerves, and other tissues and organs. Therefore, 25–36% of diabetic patients have MCI[5]. A prior pooled analysis of 14 research examined data on 2.3 million people and more than 100,000 incident dementia cases from cohorts in Asia, the Americas, and Europe reported that diabetes was significantly associated with an about 60 % increased risk of dementia[6]. Regarding specific cognitive domains, diabetic patients have decreased performance in information processing speed, impaired memory, executive function, and attention[7]. A previous meta-analysis of 24 studies reported that people with T2DM had worse neurocognitive testing compared with non-diabetic controls. Diabetic patients showed the greatest cognitive impairment in executive function, motor function, processing speed, visual memory, and verbal memory [8]. The predictors of cognitive dysfunction among diabetic patients were age, educational level, and high systolic blood pressure[9]. It is uncertain when cognitive dysfunction develops in patients with T2DM, but it has been found that cognitive impairment can occur in patients with impaired fasting glucose and maybe a very early event during the course of diabetes[10]. Therefore, early detection of cognitive impairment in patients with T2DM as well as self-management of diabetes are both beneficial for delaying cognitive impairment[11]. T2DM management is becoming more and more popular as a means of treating dementia and cognitive decline since it is becoming widely recognized that it is a risk factor for cognitive dysfunction. According to several previous studies, diabetic patients who were on oral anti-diabetes medications such as thiazolidinedione, metformin, and empagliflozin significantly reduced their risk of cognitive impairment[12]. The prevention of cardiovascular diseases (CVD) is predicted to provide an important contribution to the prevention of dementia in T2DM, even though a lack of high-quality interventional research prevents specific treatment guidance in many areas. Additionally, there is proof that cognitive impairment in T2DM is linked to poorer glycemic control, an increase in episodes of severe hypoglycemia, a higher risk of CVD, and early mortality. Primary care doctors should take this into account when treating patients who have both T2DM and cognitive impairment[13]. The exact prevalence and predictors of cognitive dysfunction in T2DM patients are still unclear, particularly among the Egyptian population due to the paucity of data. The present study aims to assess the prevalence of cognitive dysfunction in T2DM patients as well as to find out the associated factors that can increase the risk of cognitive impairment among diabetic patients; detection of these likely modifiable factors can help in identifying the high-risk patients who would benefit from early screening, aggressive management, and referral to specialists, thus preventing or delaying progression to dementia.

Subjects and Methods

Study Subjects

A Comparative Cross-sectional Study was conducted at a family medicine outpatient

clinic affiliated with Suez Canal University Hospitals in Ismailia Governorate. The study was carried out from October 2019 to October 2020. The study included T2DM patients and non-diabetic patients who were receiving health care in a family medicine outpatient clinic according to the following criteria, patients with T2DM, aged 30 years or older. Non-diabetic patients, males, and females, agreed to participate in the study. The study excluded patients with any of the following; severe depression, using the Beck Depression Inventory[14]. Hypertension, which leads to white matter ischemic damage and cognitive dysfunction, promotes Alzheimer's pathology[15]. Psychiatric disorders such as neurocognitive, neurologic, intracranial neoplasm, alcohol, or substance abuse. medical conditions that may affect cognitive function (thyroid diseases, hepatic dysfunction, malignancy, vitamin B12 deficiency, Rheumatological disorders, lung diseases, etc.). Patients who used cognition-impairing drugs in the past 4 weeks (antidepressants, benzodiazepines, anticonvulsants, and opiates). Patients with severe hearing, visual impairment, mobility, or motor coordination impairment.

Sample size

The sample size was determined by using the following equation[16].

$n = (Z\alpha/2+Z\beta)2 * (p1(1-p1) +p2(1-p2)) / (p1-p2)2$ Where n=the required sample size in each group Zα/2= 1.96 (for a confidence level of 95%, α is 0.05). Zβ= 0.84 (for a power of 80%, β is 0.2). P1 = 53.3%= is the proportion of cognitive impairment in T2DM patients[17]. P2=31.4% = is the proportion of cognitive impairment in non-diabetes patients[17]. After adding a non-response rate of 20%, the total sample size for each group was 88 patients. This study had 18 independent variables so according to the rule of thumb, the minimum sample size for logistic regression is 50+8*p where p is the number of predictors. So, the sample size would be 194 patients. The sample size was increased to 200 patients in each group.

Sampling method and Study groups:

A simple random sampling was used to select the calculated number of patients from the registry of the outpatient clinic. The enrolled patients were assigned to one of two groups.

Diabetes group (n-200)

A list of 917 T2DM patients was made by the author from registered patients at the Family Medicine outpatient clinic in Suez Canal University Hospital during the period from 1 October 2019 to 31 December 2019; 241 subjects were excluded after implementing the exclusion criteria, didn't respond to the author call or declined to participate. According to study criteria. 200 patients were selected using a simple random sample among 676 T2DM patients.

Non- Diabetic group (n-200)

The non-diabetic patient list which contained 390 patients, was made by the author at the end of the same period. 40 subjects were excluded after implementing the exclusion criteria, did not respond to the author's call, or declined to participate. 200 patients were selected using a simple random sample from 350 T2DM patients according to study criteria.

Study Variables

Participants were assessed using a semi-structured questionnaire consisting of 3 parts. The questionnaires were interviewer administered.

A. Socio-demographic characteristics and medical history

Socioeconomic status was assessed using

a validated socioeconomic status scale[18]. Every participant was asked about age, residence, marital status, educational level, occupation, and smoking status. *Medical history:* history of diabetes (duration, medication, Co-morbidities), BMI (Kg/m2), physical activity. Fasting blood glucose (FBG (mg/dl), hemoglobin A1c (HbA1c), low-density lipoprotein (LDL-c, mg/d) from medical records. Glycemic status was defined as controlled if FBG was 80–120 mg/dl or HbA1c: ≤ 7%). Diabetes Complications as Diabetic retinopathy which was assessed ophthalmologist funduscopic examination; Diabetic neuropathy was assessed by a 10-gram monofilament test, with loss of sensation in at least 2 sites indicating neuropathy; Diabetic nephropathy was defined with proteinuria and/or decreased estimated glomerular filtration rate (eGFR <90), assessed by spot urine proteinuria, and the Diabetic foot.

B. Cognitive performance:
I. Mini-Mental State Examination (MMSE). is the most common tool used globally for screening of dementia. The MMSE is an easy and quick test that assesses 7 domains of cognitive functioning (orientation, memory "immediate and short-term", language, attention, calculation, and praxis). The Arabic version of MMSE was demonstrated to be valid and reliable, with a sensitivity and specificity of 60.9% and 59.5%, respectively[19]. The cutoff point for abnormal MMSE was <24, and the results were correlated to the educational level of the participants [<21 abnormal for preparatory school education, 23 abnormal for 2ndary school education, and<24 abnormal for university education].
II. Montreal cognitive function test (MoCA-B): This was developed as a method for mild
cognitive impairment (MCI) screening. MoCA assesses the domains of language, executive functions, calculations, orientation, memory, visuo-constructional skills, attention, concentration, and conceptual thinking. A score greater than or equal to 26 was considered normal, for those with ≤12 years of education, 1 point was added to the total MoCA score. The Arabic MoCA tool showed good internal consistency (Cronbach's alpha = 0.915). MoCA test has displayed a greater sensitivity and specificity compared with the MMSE when screening for MCI among elderly persons[20].

Statistical Analysis

Patients' data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) software program version 25.0. The normality of continuous data was tested by Shapiro Wilk test**.** Descriptive characteristics for continuous variables were presented as means, standard deviations (SD) or median, interquartile range (IQR) where appropriate, and percentages for categorical variables. The chi-square test and Fischer test were used to compare categorical data, whereas the student t-test and Man Whitney test U test were used to compare numerical data between different groups where appropriate. Regression analysis was used to detect predictors and risk factors of cognitive impairment. The results were considered statistically significant at a p-< 0.05.

Ethical Considerations

The Ethics Committee of the Faculty of Medicine, Suez Canal University approved the study in October 2019 (code 3978#). Informed consent was obtained from all participants included in the study.

Results

Our study included 400 patients classified into two groups; 200 patients diagnosed

with T2DM and 200 non- diabetic patients. The mean age of diabetic patients was 59.8±9.9 years while the mean age of non-diabetic patients was 58.6±11.9 years, half of both groups were females. More than two-thirds (68%) of diabetic patients and nearly one-third (32%) of non-diabetic patients were illiterate. 20% of diabetic patients and 28% of non-diabetic patients were smokers. There were statistically significant differences between both groups regarding education, occupation, socioeconomic status (SES) and BMI means ($p<0.05$) (Table 1).

Table 1: General characteristics of diabetic patients and non-diabetic patients.

Variables	Diabetic group (N=200)	Non-Diabetic group (N=200)	Test value	P-value
Age (Yrs.) Mean ± SD	59.8±9.9	58.6±11.9	0.921	1.00[1]
Gender				
Male	100(50%)	104(52%)	0.841	1.00[3]
Female	100(50%)	96(48%)		
Marital status				
Single	0(0%)	12(6%)		
Married	132(66%)	132(66%)		
Widowed	48(24%)	36(18%)	3.095	0.423[2]
Divorced/Separated	20(10%)	20(10%)		
Education				
Illiterate	136(68%)	64(32%)		
Primary school	4(2%)	4(2%)		
Middle school	4(2%)	4(2%)		
High school	16(8%)	44(22%)	14.65	0.003*[2]
College or some college	36(18%)	80(40%)		
Post-graduate degrees	4(2%)	4(2%)		
Occupation				
Unemployed/housewife	104(52%)	48(24%)		
Farmer	72(36%)	136(68%)		
Daily laborer	16(8%)	8(4%)	10.75	0.013*[3]
Others	8(4%)	8(4%)		
Residency				
Rural	84(42%)	92(46%)	0.162	0.687[3]
Urban	116(58%)	108(54%)		
SES				
Very low	44(22%)	52(26%)		
Low	96(48%)	28(14%)	14.66	0.002*[2]
Middle	44(22%)	84(42%)		
High	16(8%)	36(18%)		
Current smokers	40(20%)	56(28%)	0.837	0.399[3]
BMI (Kg/m2) Mean ± SD	33.2±1.7	28.7±1.9	2.124	0.019*[1]

1. Independent t-test; 2. Fisher`s exact test; 3. Chi-square test.

Table 2. Clinical characteristics of type 2 diabetes mellitus patients (N=200).	
Variables	(N=200) %
Duration of DM (yrs.)	
Mean ± SD	13.24±7.9
Median (IQR)	12.5(8-17)
3 months-5 years	28(14%)
5-10 years	60(30%)
>10 years	112(56%)
Obesity	
Normal	10(5%)
Overweight	28(14%)
Obesity	162(81%)
Complications	
Diabetic retinopathy	32(16%)
Diabetic neuropathy	100(50%)
Diabetic nephropathy	48(24%)
Diabetic foot	20(10%)
Medications	
OHD	72(36%)
Insulin	88(44%)
Both	40(20%)
HbA1C Mean ±SD	8.7±1.3
FBS Mean ±SD	191.88±49.2
LDL-c (mg/d) Mean ±SD	156.5±44.3
Co-morbidities	
Dyslipidemia	72(36%)
Ischemic Heart Disease	36(18%)
Heart Failure	68(34%)
Chronic Kidney Disease	52(26%)
Physical exercise	
Daily	0(0%)
3-5 times weekly	12(6%)
1-2 times weekly	44(22%)
Not done	144(72%)
Glycemic status	
Controlled	152(76%)
Uncontrolled	48(24%)

Abbreviations: OHD; oral hypoglycemic drugs, RBS; random blood sugar, LDL; low-density lipoprotein; IQR: interquartile range.

Table 2 shows the clinical characteristics of T2DM patients; the mean duration of the diabetes was (13.24±7.9) years. Half (50%) of diabetic patients had diabetic neuropathy, and most (81%) of diabetic patients were obese. More than one-third (36%) of diabetic patients had dyslipidemia, and most (72%) of patients were physically inactive. The mean HbA1c was (8.7±1.3), and most (76%) of diabetic patients had controlled glycemic status. The diabetic group has a significantly lower mean total MMSE score (25.0±3.2) compared to the non-diabetic group (27.3±3.0) ($p<0.001$). (Table 3).

Table 3: Comparison of Cognitive Function tested by Mini-Mental State Examination (MMSE) among study groups.				
Variables	Diabetic group **(N=200)**	Non-Diabetic group **(N=200)**	Test value	P-value
Orientation Median (IQR))	9.3±0.99 7(6-9)	9.74±0.63 5(4-6)	2.639	**0.010*[1]**
Registrations Median (IQR)	2.98±0.14 2(1-3)	3±0.33 3(2-4)	1.00	0.322[1]
Calculation Median (IQR)	3.9±1.2 3(2-4)	4.4±0.95 4(3-5)	2.185	0.031*[1]
Recall Median (IQR)	1.98±0.71 1.5(1-2)	2.38±0.73 2(1-3)	2.779	0.007*[1]
Language Median (IQR)	6.88±1.29 6(5-7)	7.92±1.52 7(6-8)	3.687	<0.001*[1]
Total score Median (IQR)	25.06±3.25 25(23-28)	27.38±3.04 29(26-31)	3.687	<0.001*[1]
Cognitive Impaired *No* *Yes*	180(90%) 20(10%)	188(94%) 12(6%)	2.17	0.14[2]

*1. Man Whitney test. 2. Fisher exact test. *Statistically significant as p<0.05.*

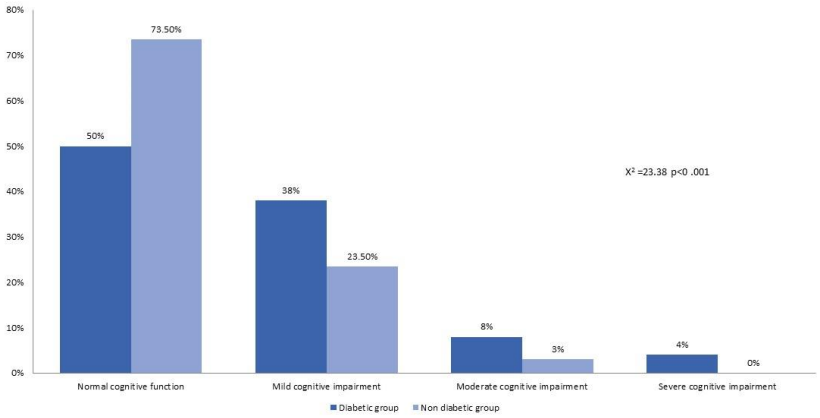

Figure 1. Severity of Cognitive impairment tested by Montreal Cognitive Assessment (MOCA) among type 2 diabetes and non-diabetic patients

Further, the mean of specific cognitive domains (orientation, calculation, recall, and language) was significantly lower in the diabetic group compared with the non-diabetic group (p<0.05). The prevalence of cognitive impairment tested by MMSE was 10% in diabetic patients compared to 6 % in the non-diabetic group (P= 0.14). Figure 1. Demonstrates the severity of cognitive impairment, according to (MOCA) score among T2DM patients and non-diabetic patients. It shows that the diabetic group had a statistically significant higher percentage of cognitive impairment (50%) compared with the non-diabetic group (26.5%) p<0.001. The prevalence of mild cognitive impairment (MCI) was (38%) of the diabetic group compared with (26.5%) of the non-diabetic group. Table 4 shows that the diabetic group has a significantly lower mean

delayed recall score (3.69±1.2) than the non-diabetic group (4.39±0.4) (p=0.041). The prevalence of cognitive impairment tested by MoCA was 50% in DM patients compared to 26.5 % in the non-diabetics (P <0.05). Table 5 shows the association between patient characteristics and cognitive status diagnosed by MMSE in DM patients, elder age, male gender, unemployment, and low socioeconomic status were significantly associated with cognitive impairment. Furthermore, increased duration of DM, physically inactive, DM complications, higher medians of FBG and LDL levels, and uncontrolled DM were significantly associated with cognitive impairment.

Table 4: Comparison of Cognitive Function tested by Montreal Cognitive Assessment (MoCA) among study groups.

	Diabetic group (N=200)	**Non-diabetic group** (N=200)	Test value	P-value
Orientation Median (IQR)	6±0.0 5(4-6)	6±0.0 6(5-7)	2.185	0.951[1]
Abstraction Median (IQR)	1.5±0.52 1(0-2)	1.7±0.47 2(1-3)	1.338	0.187[1]
Delayed recall Median (IQR)	3.69±1.2 3(2-3)	4.39±0.4 4(3-5)	2.187	0.041*[1]
Visuoperception Median (IQR)	4.5±0.89 4(2-5)	4.5±0.75 3(4-5)	0.062	0.951[1]
Language Median (IQR)	2.31±0.48 1(0-2)	2.33±0.48 2(1-4)	0.143	0.887[1]
Naming Median (IQR)	2.94±0.25 2(1-3)	3±1.0 3(2-4)	1.00	0.333[1]
Attention Median (IQR)	5.81±0.4 5(4-8)	5.88±0.42 5(4-6)	0.529	0.599[1]
Total score Median (IQR)	21.91±3.95 26(23-28)	22±4.09 28(26-31)	1.343	0.191[1]
Cognitive function *Normal* *Abnormal*	100(50%) 100(50%)	147(73.5%) 53(26.5%)	6.827	<0.001*[2]

*1. Man, Whitney test. 2. Chi-square test. *Statistically significant as p<0.05.*

Table 6 shows the results of multiple linear regression analysis of factors associated with MMSE total score in T2DM patients. Factors entered the analysis were (gender, age, occupation, education status, smoking, BMI, SES, duration of disease, HA1C, FBG, and LDL-c as independent variables, and the total score of MMSE as the dependent variable. The analysis revealed that; education and SES were significant positive predictors of MMSE score; while age, BMI, duration of disease, FBG, HbA1c, and LDL were negative predictors of MMSE score among diabetic patients.

Discussion

In the current study, cognitive impairment prevalence tested by MoCA was 50% in diabetic patients compared to 26.5 % in the non-diabetic group (P <0.05). While cognitive impairment prevalence tested by MMSE in T2DM patients was 10% compared to 6% in non-diabetic patients.

Table 5. Association between patients' characteristics and cognitive function diagnosed by MMSE in the diabetic group (n=200).					
Variables		Normal cognitive patients (N=180)	Cognitive impaired Patients (N=20)	Test value	P-value
Age	Mean±SD	57.9±9.1	70±10.2	5.614	<0.001*[1]
Gender	*Male* *Female*	84(46.7%) 96(53.3%)	16(80%) 4(20%)	8.00	0.008*[2]
Occupation	*Unemployed/housewife* *Employed*	92(51.1%) 88(48.9)	12(60%) 8(40%)	17.85	<0.001*[3]
Residency	*Rural* *Urban*	80(44.4%) 100(55.6%)	4(20%) 16(80%)	3.840	0.050[2]
Education	*Illiterate* *Literate*	120(66.7%) 60(33.3%)	16(80%) 4(20%)	1.514	0.314[2]
SES	*Very low* *Low* *Middle* *High*	32(17.8%) 88(48.9%) 44(24.4%) 16(8.9%)	12(60%) 8(40%) 0(0%) 0(0%)	18.634	<0.001*[2]
Current smokers	No. (%)	36(20%)	4(20%)	0	1.00[3]
Duration of DM (yrs.)	*Mean ± SD* *Median (IQR)* *3 months-5 years* *5-10 years* *>10 years*	5.67±2.13 5(3-7) 100(55.6%) 60(33.3%) 20(11.1%)	11.11±6.5 11(9-13) 0(0%) 0(0%) 20(100%)	7.654 10.32	<0.001*[1] <0.001*[2]
Obesity	*Normal* *Overweight* *Mild obesity* *Moderate obesity* *Morbid obesity*	10(5.6%) 28(15.6%) 93(51.7%) 45(25%) 4(2.1%)	0(0%) 0(0%) 2(10%) 5(25%) 13(65%)	1.243	0.817[2]
Physical exercise	*Daily* *3-5 times weekly* *1-2 times weekly* *Not done*	0(0%) 12(6.7%) 44(24.4%) 122(67.8%)	0(0%) 0(0%) 0(0%) 20(72%)	4.332	0.004*[2]
Complications	*retinopathy* *neuropathy* *nephropathy* *Diabetic foot*	31(17.2%) 88(48.9%) 75(41.7%) 20(11.1%)	1(5%) 18(90%) 1(5%) 0(0%)	5.322	0.002*[2]
Co-morbidities	*Dyslipidemia* *Ischemic Heart dis.* *Heart Failure* *Chronic Kidney dis.*	60(33.3%) 33(18.3%) 66(36.7%) 49(27.2%)	12(36%) 3(18%) 2(34%) 3(26%)	1.493	0.320[2]
Medications	*OHD* *Insulin* *Both*	70(38.9%) 84(46.7%) 26(14.4%)	2(10%) 4(20%) 14(70%)	5.029	<0.001*[2]
HbA1C	Median (IQR)	4(3-5)	3(2-4)	3.221	0.003*[1]
FBS	Median (IQR)	200(170-244)	220(190-273)	4.116	0.002*[1]
LDLc	Median (IQR)	166(142-224)	187(175-208)	4.322	0.005*[1]
Glycemic status	*Controlled* *Uncontrolled*	150(83.3%) 30(16.7%)	2(10%) 18(90%)	11.081	<0.001*[2]

*Abbreviations: OHD; oral hypoglycemic drugs, RBS; random blood sugar, LDL; low-density lipoprotein; HbA1C: hemoglobin A1C. 1. Man Whitney U test; 2. Fisher exact test. 3. Chi-square test. *Statistically significant as p<0.05.*

Table 6: Multiple linear regression analysis of associations between baseline characteristics and MMSE score in T2DM patients.

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	40.898	1.752		23.340	<0.001	37.441	44.355
Gender	-.240	.359	-.037	-.669	.505	-.949	.468
Age	-.048	.018	-.146	-2.714	.007*	-.083	-.013
Occupation	.032	.040	.115	.817	.420	.251	.787
Education	2.322	.369	.336	6.290	<0.001*	1.594	3.050
Smoking	-.488	.413	-.061	-1.182	.239	-1.302	.326
BMI	-.342	.166	-.087	-2.062	.041*	-.669	-.015
SES	.752	.213	.200	3.524	.001*	.331	1.173
Duration of disease	-.177	.025	-.359	-7.166	<0.001*	-.226	-.128
HbA1C	-.575	.156	-.243	-3.689	<0.001*	-.883	-.268
FBS	-.016	.004	-.249	-4.145	<0.001*	-.024	-.009
LDL-c	.012	.006	.163	2.146	.033*	.001	.023

*ANOVA model (F=8.152, p=0.001) and R2=0.76, *Statistically significant at p < 0.05*
Abbreviations: BMI; body mass index, SES: socio economic state, HbA1C: hemoglobin A1C, FBS; fasting blood sugar, LDL; low-density lipoprotein

The diabetic patients showed significantly lower scores in specific cognitive domains (orientation, calculation, recall, and language) compared with non-diabetic patients (P <0.05). Education and socioeconomic status were significant positive predictors to MMSE score; while age, BMI, duration of diabetes, FBG, HbA1c, and LDL were negative predictors for cognitive impairment tested by MMSE among T2DM patients (p<0.05). The results of the current study were in agreement with the results of a study conducted in Ethiopia, which found that cognitive impairment in patients with T2DM was 53.3% compared to 31.4% in non-diabetic individuals[17]. In Nigeria, a greater prevalence (44%) of cognitive impairment was stated in illiterate T2DM patients[21]. A study in Japan found that one-third of the diabetic patients had cognitive impairment[22]. In Saudi Arabia, India, and America, the cognitive dysfunction prevalence among diabetic patients was 12,10%, and 17.1, respectively[23-25]. All the previous studies come to support our findings to ensure the negative impact of T2DM on cognitive function. The findings of this study revealed a higher prevalence (38%) of mild cognitive impairment (MCI) among diabetic patients compared to 31.5% and 32.7% reported MCI prevalence among the Korean and Polish populations respectively[10,26]. However, another study in the Philippines revealed a higher prevalence (45%) of the MCI prevalence among elderly diabetic patients[27]. That epidemiological discrepancy of cognitive impairment among T2DM patients in previous studies could be explained by different characteristics of the study participants and recruitment criteria, and due to different tools and cutoffs used to define cognitive impairment. In this study, the performance of diabetic patients was worse on global cognition; diabetic patients had a lower mean MMSE score (25.06±3.25) compared to the non-diabetic group (27.38±3.04). Furthermore, diabetics had lower scores in partic-

ular cognitive domains of orientation, calculation, recall, and language) compared to non-diabetic patients. Kataria et al. reported that most of the diabetic patients (64.86%) had relatively modest forms of cognitive impairment with an MMSE score between 21 and 24, and the study group MMSE score mean was 24.79 ± 4.22, furthermore, the study reported domains of cognition; attention, recall, calculation, registration, orientation, and language were all affected in the study participants[28]. Our results were inconsistent with the findings of Blanquisco et al. who reported the domains that were poorly affected by diabetes were language and recall[27]. Luchsinger et al. stated that greater glycemia was correlated to lower memory and executive dysfunction among 600 Hispanics living in Manhattan[29]. On the other hand; A cross-sectional study stated that T2DM patients exhibited reduced psychomotor activity, however problem-solving skills and learning were intact[30]. This could be due to the difference in the tools used, different study participants, and recruitment criteria. In the current study, cognitive dysfunction is found to be associated with a longer duration of diabetes, being physically inactive, patients had diabetic complications, patients had uncontrolled diabetes and higher medians of both FBG and LDL. A multiple linear regression model revealed that; education and socioeconomic status were significant positive predictors of MMSE score; while age, BMI, duration of disease, FBG, HbA1c, and LDL were negative predictors of MMSE score among diabetic patients. Similarly, Kataria et al. found that cognitive dysfunction was linked with a longer duration of T2DM and poor glycemic control. However, he stated that demographic factors such as age, gender, socioeconomic status, and residence were not found to show a statistically significant association with the presence or the severity of cognitive impairment in diabetic patients[27]. Another study by Blanquisco et al. reported that age, obesity, and hypertension appear to increase the likelihood of having MCI however they were not significant[27]. On the other hand, other studies did not find any significant association between cognitive impairment and FBG or HbA1c although cognitive impairment was more frequent in diabetic patients with poorer glycemic control[31,10]. Gorska-Ciebiada et al. found no significant association between obesity and cognitive impairment[26]. A study in Saudi Arabia instead reported a protective association between obesity and cognitive function[21]. Our study stated that Socioeconomic status and educational level were positive predictors of cognitive function. The available studies suggest a negative association between education and dementia incidence. The capacity of the brain to store information is increased in those with higher levels of education and expertise, which could explain why dementia symptoms could appear 4-5 years later[32].

Study Limitations

This study has some limitations, 1) the selection bias since participants were hospital-based thus, did not truly represent a community-based sample which may overestimate the rate of cognitive impairment and the enrollment may also signify the association of T2DM and cognitive impairment. 2) the cross-sectional study could not establish causality in the association between T2DM and cognition. However, based on previous studies, we suggest that T2DM can be a risk factor for cognitive impairment.

Conclusion

In conclusion, this study gives epidemiological information about the prevalence

of cognitive impairment among diabetic patients in Egypt. This study revealed a high prevalence of cognitive impairment among T2DM patients, compared with non-diabetic patients; Further impaired specific cognitive areas (orientation, calculation, recall, and language) were higher in T2DM patients. The study revealed that; education and Socioeconomic status were significant positive predictors of MMSE score; while age, BMI, duration of disease, FBG, HbA1c, and LDL were negative predictors of MMSE score among diabetic patients. Primary care providers in Egypt should pay more attention to the cognitive function of T2DM patients, early detection of cognitive impairment in T2DM patients is conducive to the recovery of cognitive function and delayed cognitive decline. Further interventional studies aiming to reduce cognitive decline in T2DM in particular those addressing new risk factors in primary care are suggested.

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