Section: General Medicine

Original Research Article

PREDICTORS OF COGNITIVE IMPAIRMENT IN TYPE 2 DIABETES MELLITUS

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ABSTRACT

Background: Hyperglycemia in diabetes mellitus (DM) affects 415 million adults worldwide, projected to rise by 200 million by 2040, with 8–20% prevalence in those over 60. Type 2 DM, accounting for approximately 90% of cases, involves insulin resistance, impaired insulin secretion, and increased hepatic glucose production, with risk factors including obesity, sedentary lifestyle, and dyslipidemia. **Aims:** To determine the prevalence of cognitive impairment in type 2 diabetes patients and its correlation with patient-related factors.

Materials and Methods: This was a cross-sectional hospital-based study. It was conducted at the General Medicine and Outpatient Departments of Kasturba Medical College and Hospital, Mangalore. The study was carried out over duration of 18 months. A total of 209 patients were included as the study sample.

Results: Among 209 patients, 93 (44.5%) had cognitive impairment, which was significantly higher in those aged 56–60 years (71/93, 76.3%), sedentary (78/93, 83.9%), smokers (46/93, 49.5%), drinkers (54/93, 58.1%), overweight/obese (78/93, 83.9%), with SBP >120 mmHg (72/93, 77.4%), DBP >80 mmHg (68/93, 73.1%), and dyslipidemia (total cholesterol >200 mg/dl: 66/93, 71%; LDL >100 mg/dl: 68/93, 73.1%; triglycerides >150 mg/dl: 70/93, 75.3%; HDL <40 mg/dl: 74/93, 79.6%) ($p < 0.05$). Gender, marital status, education, and socioeconomic status were not significant ($p > 0.05$). Overall, metabolic, lifestyle, and vascular factors were strongly associated with cognitive impairment, while sociodemographic factors were not.

Conclusion: In 209 type 2 diabetes patients, 93 (44.5%) had cognitive impairment, significantly associated with age, lifestyle, BMI, blood pressure, and dyslipidemia, while gender and socioeconomic factors were not. Early screening and lifestyle interventions are crucial to prevent progression and improve outcomes.

Keywords: Type 2 Diabetes Mellitus, Cognitive Impairment, Predictors, Risk Factors, Glycemic Control.

INTRODUCTION

Hyperglycemia is a hallmark of several metabolic diseases collectively known as diabetes mellitus (DM), which is classified according to the underlying pathogenic mechanisms. Type 1 diabetes mellitus is characterized by insulin deficiency and a tendency toward ketosis, whereas type 2 diabetes mellitus (T2DM) represents a heterogeneous group of disorders involving insulin resistance, impaired insulin secretion, and increased hepatic glucose production.[1]According to the International Diabetes Federation (IDF), an estimated 415 million adults aged 20–79 years are living with diabetes globally, and this number is projected to rise by 200 million by 2040.[2] In adults over 60 years, prevalence ranges from 8% to 20%.[2]Chronic hyperglycemia and associated metabolic disturbances in diabetes contribute to microvascular complications such as retinopathy, nephropathy, and neuropathy, as well as macrovascular complications including coronary artery disease, cerebrovascular

disease, and peripheral arterial disease.[1] Approximately 90% of all diabetes cases are T2DM, which develops when insulin resistance reduces cellular responsiveness to insulin, and beta-cell function declines with age. While type 2 diabetes predominantly affects individuals over 45 years, rising obesity rates, sedentary lifestyles, and diets high in carbohydrates and fats have increased its prevalence among younger populations.[2] Common risk factors include smoking, obesity, hypertension, inflammation, hyperhomocysteinemia, and dyslipidemia.[1,2]Beyond physical complications, T2DM are associated with cognitive decline. Poor glycemic control over time correlates with reduced cognitive performance.[3,4,5]Although the precise mechanisms underlying cognitive impairment in T2DM remain unclear, proposed contributors include chronic hyperglycemia, vascular disease, insulin resistance, amyloidosis, hypoglycemia, hypertension, and depression.[6,7]Studies indicate that individuals with T2DM are at significantly higher risk of developing mild cognitive impairment (MCI) and dementia compared to non-diabetic populations.[6] Cognitive domains affected include verbal fluency, information processing, motor coordination, cognitive flexibility, comprehension, visual memory, attention, and both immediate and delayed recall.[6,7] Functional consequences of these neurocognitive deficits are increasingly recognized. Patients with T2DM often exhibit slower gait, impaired balance, and increased fall risk, although the contribution of cerebral changes to these deficits remains under investigation. Furthermore, T2DM patients have a twofold higher risk of depression, which may exacerbate cognitive and functional impairments.[6] Older adults with T2DM frequently experience challenges in activities of daily living, cognitive decline, and depression, with reported prevalence rates of 17.5%, 11.3%, and 14.2%, respectively.[7] Cognitive function in T2DM is influenced by multiple factors, including age, socioeconomic status, education, comorbidities, HbA1c levels, and lipid profiles, highlighting a complex interplay of biological and social determinants.[6,7] Age-related cortical and subcortical atrophy, including parahippocampal gyrus involvement, contributes to memory loss and diminished cognitive performance.[6] Socioeconomic disparities affect diabetes incidence, glycemic control, and complication rates, while education is positively associated with cognitive reserve, influencing diabetes risk and cognitive outcomes.[7]Collectively; these findings underscore the multifaceted relationship between T2DM, cognitive function, and daily life. The interplay of metabolic, vascular, and neurodegenerative processes, compounded by psychosocial factors, highlights the need for comprehensive management strategies addressing both glycemic control and cognitive health in individuals with T2DM.To determine the prevalence of cognitive impairment in type 2 diabetes patients and its correlation with patient-related factors.

MATERIALS AND METHODS

Type of Study: This is a cross-sectionalhospital-based study done in 209 patients

Place of Study: General medicine and outpatient departments of Kasturba Medical College and Hospital in Mangalore.

Study Duration: They study was done for a period of 18 months

Sample Size:209 Patients

Inclusion Criteria

- Patients with a history of type 2 diabetes mellitus for at least two years, ranging in age from thirty to sixty-five
- Individuals of any gender
- Literate patients (who are able to read and write kannada).
- Consenting patients

Exclusion Criteria

- Diabetics with previous history/diagnosed of
- Senile dementia
- Vascular dementia
- Neuro degenerative disorders
- Epilepsy/Patients on anti-epileptics
- Psychiatric illness
- Hypothyroidism
- Stroke/encephalopathy
- Head injury
- Family history of senile dementia.

Statistical Analysis: For statistical analysis, data were first entered into a Microsoft Excel spreadsheet and subsequently analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Continuous numerical variables were summarized as mean ± standard deviation, while categorical variables were expressed as counts and percentages. The Z-test (Standard Normal Deviate) was employed to assess significant differences between proportions. For comparisons involving means, the student's t-test was used, with the corresponding p-value obtained from the t-distribution table. A p-value ≤ 0.05 was considered statistically significant, indicating rejection of the null hypothesis in favor of the alternative hypothesis.

RESULTS

Table 1: Demographic, Lifestyle, and BMI Characteristics of Patients with and without Cognitive Impairment

	Parameters	Total Patients (N=209)	With Cognitive Impairment (N=93)	Without Cognitive Impairment (N=116)	P Value
Age (years)	35–45	59	2 (2.2%)	57 (49.1%)	<0.0003
	46–55	57	20 (21.5%)	37 (31.9%)	
	56–60	93	71 (76.3%)	22 (19%)	
Gender	Male	119	49 (52.7%)	70 (60.3%)	0.14
	Female	90	44 (47.3%)	46 (39.7%)	
Type of Activity	Sedentary	113	78 (83.9%)	35 (30.2%)	0.0032
	Active	96	15 (16.1%)	81 (69.8%)	
Smoking Status	Non-smoking	112	25 (26.9%)	87 (75%)	<0.0001
	Smoking	65	46 (49.5%)	19 (16.4%)	
	Ex-smoker	32	22 (23.7%)	10 (8.6%)	
Alcohol Status	Non-drinker	106	18 (19.4%)	88 (75.9%)	<0.0001
	Drinker	76	54 (58.1%)	22 (19%)	
	Ex-drinker	27	21 (22.6%)	6 (5.2%)	
BMI (kg/m²)	<18.4 (Underweight)	11	3 (3.2%)	8 (6.9%)	<0.0001*
	18.5–24.9 (Normal)	78	12 (12.9%)	66 (56.9%)	
	25–29.9 (Overweight)	73	45 (48.4%)	28 (24.1%)	
	30–34.9 (Obese)	47	33 (35.5%)	14 (12.1%)	

Table 2: Clinical and Biochemical Parameters of Patients with and without Cognitive Impairment

Parameter	Cut-off	Total Patients (N=209)	With Cognitive Impairment (N=93)	Without Cognitive Impairment (N=116)	P Value
Systolic BP (SBP)	<120 mmHg	125	21 (22.6%)	104 (89.7%)	<0.0001
	>120 mmHg	84	72 (77.4%)	12 (10.3%)	
Diastolic BP (DBP)	<80 mmHg	128	25 (26.9%)	103 (88.8%)	<0.0001
	>80 mmHg	81	68 (73.1%)	13 (11.2%)	
Postural Drop	Yes	50	36 (38.7%)	14 (12.1%)	0.016
	No	159	57 (61.3%)	102 (87.9%)	
Total Cholesterol	<200 mg/dl	123	27 (29%)	96 (82.8%)	0.0004
	>200 mg/dl	86	66 (71%)	20 (17.2%)	
LDL Cholesterol	<100 mg/dl	95	25 (26.9%)	70 (60.3%)	<0.0001
	>100 mg/dl	114	68 (73.1%)	46 (39.7%)	
Triglycerides	<150 mg/dl	89	23 (24.7%)	66 (56.9%)	<0.0001
	>150 mg/dl	120	70 (75.3%)	50 (43.1%)	
HDL Cholesterol	>40 mg/dl	98	19 (20.4%)	79 (68.1%)	<0.0001
	<40 mg/dl	111	74 (79.6%)	37 (31.9%)	

Table 3: Distribution of Patients by Marital Status, Educational Level, and Socioeconomic Status

		Total Patients (N=209)	With Cognitive Impairment (N=93)	Without Cognitive Impairment (N=116)
Marital Status	Single	64	32 (34.4%)	32 (27.6%)
	Married	141	60 (64.5%)	81 (69.8%)
	Others	4	1 (1.1%)	3 (2.6%)
Educational Status	Matriculation	93	42 (45.2%)	51 (44%)
	Secondary	76	33 (35.5%)	43 (37.1%)
	Graduation	40	18 (19.4%)	22 (18.9%)
Socioeconomic Status	High	112	51 (54.8%)	61 (52.6%)
	Middle	75	32 (34.4%)	43 (37.1%)
	Low	22	10 (10.8%)	12 (10.3%)

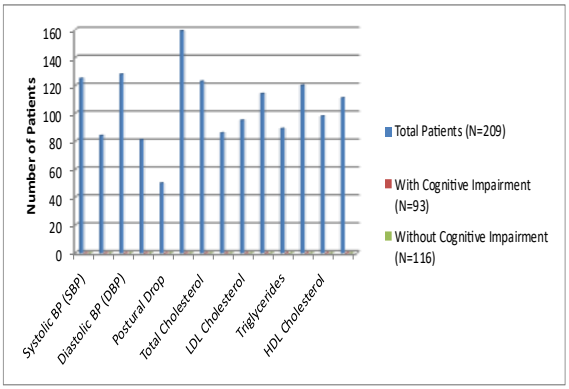

Figure 1: Clinical and Biochemical Parameters of Patients with and without Cognitive Impairment

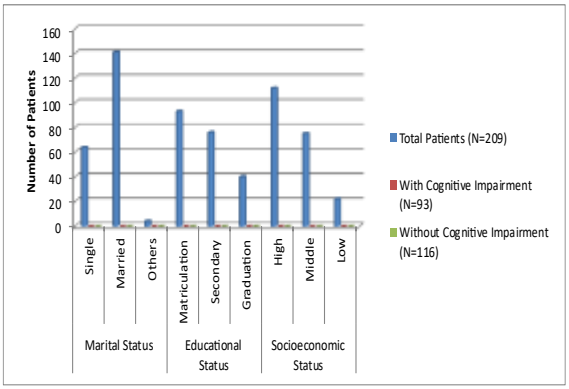

Figure 2: Distribution of Patients by Marital Status, Educational Level, and Socioeconomic Status

In this study of 209 patients, cognitive impairment was observed in 93 (44.5%) and absent in 116 (55.5%). Age was significantly associated with cognitive impairment, with the highest prevalence in patients aged 56–60 years (71/93, 76.3%) compared to 35–45 years (2/93, 2.2%) and 46–55 years (20/93, 21.5%) ($p < 0.0003$, significant). Gender was not significantly associated, with 49/93 (52.7%) males and 44/93 (47.3%) females affected ($p = 0.14$, not significant). Physical activity showed a significant correlation; 78/93 (83.9%) sedentary patients had cognitive impairment compared to 15/93 (16.1%) active patients ($p = 0.0032$, significant). Smoking status was significantly associated, with 46/93 (49.5%) smokers and 22/93 (23.7%) ex-smokers showing cognitive impairment, whereas only 25/93 (26.9%) non-smokers were affected ($p < 0.0001$, significant). Alcohol use was also significantly correlated; 54/93 (58.1%) drinkers and 21/93 (22.6%) ex-drinkers had cognitive impairment compared to 18/93 (19.4%) non-drinkers ($p < 0.0001$, significant). BMI was significantly associated with cognitive impairment, with 45/93 (48.4%) overweight and 33/93 (35.5%) obese patients affected, compared to 12/93 (12.9%) with normal BMI and 3/93 (3.2%) underweight patients ($p < 0.0001$, significant).

Among the 209 patients, 93 (44.5%) had cognitive impairment while 116 (55.5%) did not. Age was significantly associated with cognitive impairment, with the highest prevalence in patients aged 56–60 years (71/93, 76.3%) compared to 35–45 years (2/93, 2.2%) and 46–55 years (20/93, 21.5%) ($p < 0.0003$, significant), while gender was not significant ($p = 0.14$). Sedentary lifestyle (78/93, 83.9%; $p = 0.0032$), smoking (46/93, 49.5%) and ex-smoking (22/93, 23.7%; $p < 0.0001$), and alcohol use (54/93, 58.1%) and ex-drinking (21/93, 22.6%; $p < 0.0001$) were significantly associated with cognitive impairment. Overweight (45/93, 48.4%) and obese patients (33/93, 35.5%) had higher prevalence than normal (12/93, 12.9%) and underweight (3/93, 3.2%) patients ($p < 0.0001$). Elevated systolic (>120 mmHg, 72/93, 77.4%) and diastolic BP (>80 mmHg, 68/93, 73.1%) were significantly associated ($p < 0.0001$), and postural drop was also significant (36/93, 38.7%; $p = 0.016$). Dyslipidemia was strongly correlated with cognitive impairment: total cholesterol >200 mg/dl (66/93, 71%; $p = 0.0004$), LDL >100 mg/dl (68/93, 73.1%; $p < 0.0001$), triglycerides >150 mg/dl (70/93, 75.3%; $p < 0.0001$), and HDL <40 mg/dl (74/93, 79.6%; $p < 0.0001$), indicating that older age, sedentary lifestyle, unhealthy habits, higher BMI, elevated BP, and abnormal lipid profiles are significantly associated with cognitive impairment in type 2 diabetes patients.

Among the 209 patients, 93 (44.5%) had cognitive impairment while 116 (55.5%) did not. Cognitive impairment was observed in 32/93 (34.4%) single patients, 60/93 (64.5%) married patients, and 1/93 (1.1%) categorized as others; marital status was not significantly associated with cognitive impairment (p not significant). Regarding education, 42/93 (45.2%) patients with matriculation, 33/93 (35.5%) with secondary education, and 18/93 (19.4%) with graduation had cognitive impairment, showing no significant association (p not significant). Socioeconomic status also did not show a significant effect, with 51/93 (54.8%) high, 32/93 (34.4%) middle, and 10/93 (10.8%) low socioeconomic status patients affected (p not significant). Overall, marital status, educational level, and socioeconomic status were not significantly associated with cognitive impairment in this cohort.

DISCUSSION

This study of 209 patients with type 2 diabetes revealed that cognitive impairment was present in 93 (44.5%) individuals. Age was significantly associated with cognitive impairment, with the highest prevalence in patients aged 56–60 years (71/93, 76.3%) compared to 35–45 years (2/93, 2.2%) and 46–55 years (20/93, 21.5%) ($p < 0.0003$).[8]Gender did not show a significant association ($p = 0.14$). A sedentary lifestyle (78/93, 83.9%; $p = 0.0032$), smoking (46/93, 49.5%) and ex-smoking (22/93, 23.7%; $p < 0.0001$), and alcohol use (54/93, 58.1%) and ex-drinking (21/93, 22.6%; $p < 0.0001$) were significantly associated with cognitive impairment.[9,10]Overweight (45/93,

48.4%) and obese patients (33/93, 35.5%) had higher prevalence than normal (12/93, 12.9%) and underweight (3/93, 3.2%) patients ($p < 0.0001$).[11]Elevated systolic (>120 mmHg, 72/93, 77.4%) and diastolic BP (>80 mmHg, 68/93, 73.1%) were significantly associated ($p < 0.0001$), and postural drop was also significant (36/93, 38.7%; $p = 0.016$).[12]Dyslipidemia was strongly correlated with cognitive impairment: total cholesterol >200 mg/dl (66/93, 71%; $p = 0.0004$), LDL >100 mg/dl (68/93, 73.1%; $p < 0.0001$), triglycerides >150 mg/dl (70/93, 75.3%; $p < 0.0001$), and HDL <40 mg/dl (74/93, 79.6%; $p < 0.0001$).[13-15]These findings align with previous studies highlighting the impact of age, lifestyle factors, and metabolic abnormalities on cognitive function in type 2 diabetes patients.

CONCLUSION

In this study of 209 patients with type 2 diabetes, cognitive impairment was observed in 93 (44.5%) individuals, highlighting a substantial burden of cognitive decline in this population. Older age, particularly 56–60 years, sedentary lifestyle, smoking, alcohol consumption, higher BMI, elevated systolic and diastolic blood pressure, postural hypotension, and dyslipidemia (high total cholesterol, LDL, triglycerides, and low HDL) were all significantly associated with cognitive impairment, indicating that both metabolic and lifestyle factors contribute substantially to cognitive dysfunction. In contrast, gender, marital status, educational level, and socioeconomic status were not significantly associated, suggesting that biological and behavioral factors play a more direct role than social determinants. These findings underscore the importance of early screening and intervention for cognitive impairment in type 2 diabetes patients, focusing on lifestyle modification, cardiovascular and metabolic control, and patient education to prevent progression, improve self-management, and enhance overall quality of life.

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