

Original Research Article

Cognitive impairment in diabetes mellitus: an exploratory study

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ABSTRACT

Background: Present study was conducted to estimate the prevalence and evaluate predictors of cognitive function impairment in patients with type 2 diabetes mellitus.

Methods: This prevalence study was conducted over one year at a tertiary care teaching hospital in central India. Known cases of type 2 diabetes mellitus of more than one year of duration of illness were considered eligible. Patients with past history of head injury, seizure episode, stroke, chronic kidney disease, those taking antidepressant/antipsychotic treatment and those with pre-existing dementia were excluded. Mini-mental state examination was employed for estimation of the cognitive function. Clinical history, examination and biochemical findings were also evaluated.

Results: In all, total 332 patients with mean age of 61.33 ± 11.33 years were studied. Two hundred patients (60.24%) were below 60 years, and 132 patients (39.76%) were over 60 years of age. Two hundred sixteen patients (65.06%) were males, and 116 (34.96%) were females. The mean duration of diabetes mellitus (DM) was 10.17 ± 4.81 years. The mean MMSE score was 22.69 ± 5.26 and 81 (24.4%) patients were observed to have cognitive impairment. The difference in cognitive function between those below 60 years and above 60 years was statistically significant ($p=0.0214$). Duration of illness was also a significant factor ($p=0.0394$). But gender was not observed to affect the cognitive function significantly ($p=0.2497$).

Conclusions: Cognitive impairment is common amongst diabetics and is directly related to age and duration of diabetes amongst them; while gender does not influence the cognitive function amongst diabetics.

Keywords: Cognitive function, Brain, Diabetes, MMSE

INTRODUCTION

Diabetes mellitus is a chronic disease condition affecting multiple systems & organs. Going by the WHO definition of diabetes, it affects around 5%-10% of the world adult population, majority of them having type 2 diabetes mellitus.^{1,2} As many as 463 million people were reportedly affected with diabetes in the year 2019.² Over the past 3 decades, the prevalence of diabetes has nearly doubled amongst men and risen by 60% in women; affecting south-east Asia region particularly hard.^{3,4} The commonly noted micro and macro-vascular complications of diabetes include cardiovascular and

cerebrovascular disease, peripheral vascular disease, retinopathy and end-stage renal disease.⁵ Diabetes multiplies the risk of all-site cancer (except prostatic carcinoma).⁵ It also increases the risk of mental health illnesses among patients, such as depression.⁶ These complications are generally well known to the healthcare providers and are usually dealt with adequately, according to the resources available. However, a problem commonly ignored by healthcare providers is the link between diabetes and cognitive dysfunction. This is despite the relationship being well established in the literature. In recent years, several studies have shown strong evidence for the presence of cognitive impairment

in diabetes.⁷⁻⁹ One recent meta-analysis estimated the prevalence of mild cognitive impairment type 2 diabetes mellitus (T2DM) patients to range as high as 45%.¹⁰ Insulin resistance and obesity, chronic low-grade inflammation and cardiovascular complications of diabetes may be some of the risk factors implicated in development of cognitive impairment in patients.^{11,12} The cognitive domains known to have been affected include memory and processing speed. The verdict on the executive function is still not out though.^{13,14} There is a significant dearth of studies from this part of the world which explore the relationship between type 2 diabetes and cognitive impairment. The present study intends to bridge this gap by estimating the prevalence & evaluating predictors of cognitive function impairment in patients with type 2 diabetes mellitus.

METHODS

This was a descriptive, prevalence study conducted at a tertiary care teaching hospital in Central India (Dr Punajbrao Deshmukh memorial medical college & hospital, Amravati, Maharashtra) over 12 months period (January 2021 to December 2021). Patients with age greater than 50 years with diabetes mellitus formed the study population. Following WHO criteria was adopted for the diagnosis of diabetes mellitus: Random blood sugar greater than 200 mg/dl, fasting blood sugar level greater than 126 mg/dL, or HbA1c levels greater than 6.5%.¹

Inclusion and exclusion criteria

All patients with type 2 diabetes mellitus diagnosed at least one year back, irrespective of gender, were included in the study. Exclusion criteria comprised of past history of head injury, seizure episode, stroke, chronic kidney disease, those taking antidepressant/antipsychotic treatment, those with pre-existing dementia and those who refused to consent for the study.

Procedure

A total of 332 such participants were enrolled for the study using consecutive sampling during the study period. All the participants were asked to sign & submit a written informed consent before participation and the data collection was started only after approval for the study from the Institutional Ethics Committee. A back-translated and validated version of mini-mental state examination (MMSE) was employed for assessment of cognitive function of each eligible participant. The MMSE documents various domains of cognitive functioning; including spatial and temporal orientation, immediate memory, attention/concentration, delayed recall and language.¹⁵ Patients with scores < 23 out of 30 were labelled to have cognitive impairment. The socio-demographic details, relevant clinical history, examination and biochemical findings were also recorded and evaluated. The collected data were analyzed using

SPSS (version 20). For categorical variables like gender and presence or absence of cognitive impairments, frequencies along with percentages were calculated. For quantitative variables like age and the exact MMSE score, the mean and standard deviation was calculated. Factors such as age, gender, and duration of diabetes were controlled through stratification. Chi-square test was applied post-stratification, p value less than 0.05 was considered statistically significant.

RESULTS

Data of a total of 332 participants was available for final analysis. The mean±standard deviation age of the study population was 61.33±11.33 years, with the maximum age being 73 years and the minimum being 50 years. Two hundred patients (60.24%) were below 60 years of age, and 132 patients (39.76%) were 60 years of age or above. Two hundred sixteen (65.06%) were males, and 116 (34.94%) were females. The mean duration of DM was 10.17±4.81. The mean MMSE score was 22.69±5.26 (Table 1).

Table 1: Age and gender distribution of study participants (n=332).

Variable	N	%
Age (years)		
<60	200	60.24
>60	132	39.76
Gender		
Male	216	65.06
Female	116	34.94

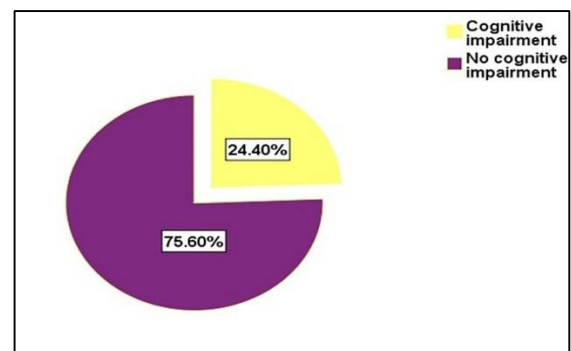


Figure 1: Proportion of cognitive impairment amongst participants.

Out of 332 patients, 81 (24.4%) patients were reported to have cognitive impairment as per the MMSE scores (Figure 1). Patients who were 60 years or older had a statistically higher proportion of cognitive impairment, compared to those below 60 years of age ($p=0.0214$). There was no significant difference in the proportion of cognitively impaired patients across genders ($p=0.2497$). The difference in cognitive impairment between those who had type 2 diabetes mellitus for 10 years or more

and those with type 2 diabetes mellitus for less than 10 years was statistically significant ($p=0.0394$) (Table 2).

Table 2: Prevalence of cognitive impairment amongst type 2 diabetics in relation with age, gender, and duration of type 2 diabetes mellitus.

Variable	Cognitive Impairment N (%)		P value
	Yes	No	
Age (years)			
<60 (N=200)	40 (20.0)	160 (80.0)	0.0214
>60 (N=132)	41 (31.1)	91 (68.9)	
Gender			
Male (N=216)	57 (26.4)	159 (73.6)	0.250
Female (N=116)	24 (20.7)	92 (79.3)	
Duration of type 2 diabetes mellitus (years)			
>10 (N=102)	28 (27.5)	74 (72.5)	0.0394
<10 (N=230)	53 (23.0)	177 (77.0)	

DISCUSSION

The present study forayed into exploration of relationship between diabetes mellitus and cognitive impairment, along with evaluation of impact of associated variables. Nearly every fourth patient suffering from type 2 diabetes mellitus was observed to have cognitive impairment as well. This high a proportion is in line with findings from the previously similar studies across available literature. Kant et al. had reported this proportion at 33.73%; other studies have observed it to range between 3% to 23%.¹⁶⁻¹⁸ Increasing age was observed to be a significant risk factor for the development of cognitive impairment in type 2 diabetics in the present study. This observation also sits well with the previously reported evidence.¹⁹ The plausible theory is that, since diabetes mellitus and old age are both independent risk factors for development of Alzheimer's disease, vascular dementia, and other disorders resulting in the eventual cognitive decline; a combination of both can contribute to a higher incidence of cognitive impairment among older diabetics.²⁰ No significant difference in cognitive impairment was observed between the genders. This is in contrast to previous similar studies; which have observed the diabetic women to have double the risk of neurocognitive impairment as compared to the men; and thus eventually reporting female gender as an independent risk factor for the development of neurocognitive deficit.^{21,22} Relative risks of as high as 3.75 have been described for development of cognitive impairment in women compared to men.²³ Perhaps, a larger sample size could have shed more light on this relationship. The duration of T2DM was seen to affect the risk of cognitive impairment significantly in the present study. This is in-line with previous relevant available evidence. One study showed that patients who have been diagnosed with T2DM for five years or more perform worse in aspects of cognition such as logical memory and word fluency compared to those who have been diagnosed newly.²⁴ A study of the Iranian population reported a negative

correlation between MMSE scores and the duration of T2DM.²⁵ Similarly, a study conducted in the US showed that diabetic individuals with a duration of diabetes for more than 10 years were 4.34 times more likely to develop cognitive impairment compared to the newly diagnosed diabetics.²⁶ Awareness of cognitive dysfunction in type 2 diabetes mellitus can help in better counseling of the patients and their families. It can lead to directing more resources and expertise towards the issue. It can also lead to a better multidisciplinary approach, such as the involvement of the neurologist as a default. Cognitive impairment might be one of the multitudes of reasons for poor compliance of the patients to lifestyle modifications and pharmacotherapy used to manage the disease. Patient education regarding cognitive impairment would help them better understand the problems they are facing. This might lead to better compliance to treatment and good glycemic control. Also, education of the family and other caregivers regarding the presence of cognitive dysfunction might help them better understand the problems the patient is facing, and as a result, patient care may eventually improve. Results of the present study may have been influenced by certain potential limitations. Firstly, age and education can influence MMSE scoring to judge neurocognition. Secondly, since the sensitivity of MMSE for timed elements of executive functions and memory is low, residual confounding for them may have remained to be exposed. Thirdly, the number of diabetic patients included in the study might be small and a larger cohort could have better elucidated the relationships we investigated. Fourthly, the hospital-based sample may not be representative of the population in general and hence generalizability of findings remains dubious.

CONCLUSION

Cognitive impairment is common in individuals having type 2 diabetes mellitus; almost as common as its other micro- and macro-vascular complications. Awareness & sensitization towards this important complication of a common clinical condition among physicians, patients, and their caregivers can go a long way in improving patients' quality of life.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: report of a WHO/IDF consultation. Available at: https://www.who.int/diabetes/publications/Definition%20and%20diagnosis%20of%20diabetes_new.pdf. Accessed on 20 November 2021.
2. Saeedi P, Salpea P, Karuranga S, Petersohn I, Malanda B, Gregg EW, et al. Mortality attributable to diabetes in 20-79 years old adults, 2019

- estimates: Results from the International Diabetes Federation Diabetes Atlas. *Diab Res Clin Pract.* 2020;162:108086.
3. Zhou B, Lu Y, Hajifathalian K, Bentham J, Di Cesare M, Danaei G, et al. Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4·4 million participants. *Lancet.* 2016;387(10027):1513-30.
4. Basit A, Fawwad A, Qureshi H, Shera AS. Prevalence of diabetes, pre-diabetes and associated risk factors: second National diabetes survey of pakistan (NDSP), 2016-2017. *BMJ.* 2018;8(8):e020961.
5. Chan JC, Lim LL, Wareham NJ, Shaw JE, Orchard TJ, Zhang P, et al. Commission on diabetes: using data to transform diabetes care and patient lives. *Lancet.* 2020;396(10267):2019-82.
6. Pan A, Lucas M, Sun Q, van Dam RM, Franco OH, Manson JE, et al. Bidirectional association between depression and type 2 diabetes mellitus in women. *Arch Int Med.* 2010;170(21):1884-91.
7. Pasquier F. Diabetes and cognitive impairment: how to evaluate the cognitive status?. *Diab Metab.* 2010;36:S100-5.
8. Paul KC, Jerrett M, Ritz B. Type 2 diabetes mellitus and Alzheimer's disease: overlapping biologic mechanisms and environmental risk factors. *Curr Environ Health Rep.* 2018;5(1):44-58.
9. Umegaki H. Type 2 diabetes as a risk factor for cognitive impairment: current insights. *Clin Interv Aging.* 2014;9:1011.
10. You Y, Liu Z, Chen Y, Xu Y, Qin J, Guo S, et al. The prevalence of mild cognitive impairment in type 2 diabetes mellitus patients: a systematic review and meta-analysis. *Acta Diabetol.* 2021; 58(6):671-85.
11. Middleton LE, Yaffe K. Promising strategies for the prevention of dementia. *Arch Neurol.* 2009;66(10): 1210-5.
12. Kalyani RR, Corriere M, Ferrucci L. Age-related and disease-related muscle loss: the effect of diabetes, obesity, and other diseases. *Lancet Diab Endocrinol.* 2014;2(10):819-29.
13. Awad N, Gagnon M, Messier C. The relationship between impaired glucose tolerance, type 2 diabetes, and cognitive function. *J Clin Exper Neuropsychol.* 2004;26(8):1044-80.
14. Saczynski JS, Jónsdóttir MK, Garcia ME, Jonsson PV, Peila R, Eiriksdóttir G, et al. Cognitive impairment: an increasingly important complication of type 2 diabetes: the age, gene/environment susceptibility-Reykjavik study. *Am J Epidemiol.* 2008;168(10):1132-9.
15. Folstein MF, Folstein SE, McHugh PR. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12(3):189-98.
16. Kant R, Yadav P, Barnwal S, Dhiman V, Abraham B, Gawande K. Prevalence and predictors of depression in type 2 diabetes mellitus. *J Edu Health Promot.* 2021;10:23-9.
17. Allen KV, Frier BM, Strachan MW. The relationship between type 2 diabetes and cognitive dysfunction: longitudinal studies and their methodological limitations. *Eur J Pharmacol.* 2004; 490(1-3):169-75.
18. Ryan CM, Freed MI, Rood JA, Cobitz AR, Waterhouse BR, Strachan MW. Improving metabolic control leads to better working memory in adults with type 2 diabetes. *Diab Care.* 2006; 29(2):345-51.
19. Bruce DG, Casey GP, Grange V, Clarnette RC, Almeida OP, Foster JK, Ives FJ, Davis TM. Cognitive impairment, physical disability and depressive symptoms in older diabetic patients: the Fremantle Cognition in Diabetes Study. *Diabetes research and clinical practice.* 2003 Jul 1;61(1):59-67.
20. Zilliox LA, Chadrasekaran K, Kwan JY, Russell JW. Diabetes and cognitive impairment. *Curr Diab Rep.* 2016;16(9):1-1.
21. Ho SC, Woo J, Sham A, Chan SG, Yu AL. A 3-year follow-up study of social, lifestyle and health predictors of cognitive impairment in a Chinese older cohort. *Int J Epidemiol.* 2001;30(6):1389-96.
22. Irvine K, Laws KR, Gale TM, Kondel TK. Greater cognitive deterioration in women than men with Alzheimer's disease: a meta analysis. *J Clin Exper Neuropsychol.* 2012;34(9):989-98.
23. Yu ES, Liu WT, Levy P, Zhang MY, Katzman R, Lung CT, et al. Cognitive impairment among elderly adults in Shanghai, China. *J Gerontol.* 1989; 44(3):S97-106.
24. Elias PK, Elias MF, D'Agostino RB, Cupples LA, Wilson PW, Silbershatz H, et al. NIDDM and blood pressure as risk factors for poor cognitive performance: the Framingham Study. *Diab Care.* 1997;20(9):1388-95.
25. Gottesman RF, Rawlings AM, Sharrett AR, Albert M, Alonso A, Bandeen-Roche K, et al. Impact of differential attrition on the association of education with cognitive change over 20 years of follow-up: the ARIC neurocognitive study. *Am J Epidemiol.* 2014;179(8):956-66.
26. Abbott MA, Wells DG, Fallon JR. The insulin receptor tyrosine kinase substrate p58/53 and the insulin receptor are components of CNS synapses. *J Neurosci.* 1999;19(17):7300-8.

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