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Mild cognitive impairment effects on diabetes self-care in Tabuk City, Saudi Arabia

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Abstract. – OBJECTIVE: The diabetes epidemic is increasing at an alarming rate in Saudi Arabia. Diabetes and dementia share some pathogeneses, including inflammatory markers, oxidative stress, and insulin resistance. Dementia may substantially influence diabetes self-care activities (DCSAs), thereby initiating a vicious cycle of complications. Therefore, this study aims to assess the effects of mild cognitive impairment (MCI) on DSCA.

PATIENTS AND METHODS: This cross-sectional study was conducted among 206 consecutive patients attending the diabetes center in Tabuk City, Saudi Arabia, during the period from December 2021 to November 2022. A structured questionnaire was administered face-to-face, including sociodemographic data, the Diabetes Self-care Questionnaire, the Mini Cognitive Assessment Tool, and the Hospital Anxiety and Depression Questionnaire. All the participants signed a written informed consent form, and both the Ethical Committees of the University of Tabuk and the Directorate General of Health Affairs, Tabuk, approved the research.

RESULTS: There were 206 patients with diabetes (63.1% women). Dyslipidemia, hypertension, and depression were reported in 59.8%, 55.9%, and 24.3% of patients, respectively, while MCI was reported in 51.5% of patients. MCI was positively correlated with age. MCI also had negative effects on diabetes self-care activities and HbA1c, but these effects were not statistically significant (odds ratio, 0.750, 95% CI, 0.56-1.00, *p*-value, 0.055, and odds ratio, 1.21, 95% CI, 0.99-1.08, *p*-value, 0.081, respectively). No significant relationship was found regarding the duration of diabetes, depression, and dyslipidemia (95% CI, 0.95-1.09, 0.32-4.57, and 0.76-8.30, respectively).

CONCLUSIONS: MCI and associated comorbidities were common among patients with diabetes in Tabuk, Saudi Arabia. No association was found between MCI and DSCA, dyslipidemia, hypertension, or duration of diabetes.

Key Words:
Mild cognitive impairment, Diabetes self-care, Depression, Saudi Arabia.

Abbreviations

DM: diabetes mellitus; AD: Alzheimer's disease; DSCA: diabetes self-care activities; MCI: mild cognitive impairment; SPSS: Statistical Package for Social Sciences; HADS: Hospital Anxiety and Depression Scale; Mini-Cog©: Mini Cognitive Assessment Tool.

Introduction

Diabetes mellitus (DM) is an epidemic, and the disease is of great concern due to its increasing prevalence. Currently, 9.3% of the global population suffers from DM, and the suffering is reflected on families, health care systems, and national economies[1]. The number of DM cases is expected to grow to 700 million by 2045. In addition, 50.1% of people living with DM have not been diagnosed[2]. The direct global expenditure on diabetes mellitus was 760 billion US dollars in 2019, and this figure is expected to increase to 845 billion US dollars in 2045[3,4]. The Kingdom of Saudi Arabia is among the countries with the highest prevalence of diabetes (18.2%-31.6% for type 2 diabetes), leading to a heavy burden on the health care system[5]. Dementia (a seriously disabling disease) is on the rise globally due to the aging population. It is estimated that 130 million people had dementia in 2015; however, this number might not reflect the actual incidence due to insufficient data and the challenge of case ascertainment[6]. The increasing prevalence of individuals with a high body mass index (BMI) – due to physically inactive work and unhealthy diets – is mirrored by the emergence of multimorbid noncommunicable diseases, thus leading to a real nightmare for health care systems. This situation is further complicated by the higher rates in low/middle-income countries that lack well-established care[7]. Most chronic noncommunicable diseases, including diabetes and dementia, share the same pathology, and the association between dementia and diabetes mellitus is complex. Diabetes mellitus is associated with increased

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dementia, and Sirtuins, the accumulation of advanced glycation end products, and the amyloid-β precursor protein are suggested[8,9] to mediate the crosstalk between diabetes mellitus and neurodegenerative conditions, including Alzheimer's disease (AD). Some have suggested that AD is a neurodegenerative disorder similar to type 2 diabetes (type 3 diabetes or brain diabetes)[10]. Thus, the bridge linking diabetes and AD is from signaling to all stages of treatment, namely, adherence to lifestyles and medications and holistic patient care. Although the benefits of lifestyle intervention are well established among patients with diabetes, the role of this important intervention has yet to be elucidated among patients with both diabetes and cognitive decline[11,12]. It is recommended that the patient's general health, values, and cognitive function are evaluated for those diagnosed with diabetes above 65 years of age. In addition, the treatment should be simplified, and the goals and interventions should be tailored accordingly. The patient is at the center of diabetes care, and dementia may substantially disturb the multidisciplinary patient-centered approach[13].

Dementia/cognitive impairment may negatively influence all the components of diabetes self-care, namely, disease knowledge, adjusting insulin doses, finding/utilization of resources, interaction with health-care providers, action taking, and adherence to diabetic medications and lifestyles[14]. The result is poor glycemic control and a deficit in routine visits and essential investigations culminating in a vicious circle. On the other hand, patients with dementia/CogImp are prone to hypoglycemia and cognitive decline[15]. There is a strong link between diabetes mellitus and dementia; however, relevant literature is lacking worldwide, particularly in the Kingdom of Saudi Arabia. Assessing the associations of diabetes with cognitive impairment and depression is vital for integrated care and improvement of outcomes. Therefore, the current survey aims to assess the effects of dementia on diabetes self-care, including lifestyles, foot care, glucose monitoring, and adherence to medications, in Tabuk City, Saudi Arabia.

Patients and Methods

Setting

Diabetes mellitus and dementia are common causes of mortality and morbidity; they negatively affect the patient's physical health, mental health and quality of life. Diabetes self-management is an essential component in diabetes management that may be affected by dementia and lead to diabetes microvascular and macrovascular complications, initiating a vicious cycle with deleterious consequences on the patients, family, health care system, and the whole community. These important health care problems have not been assessed in Saudi Arabia.

Study Type and Area

This cross-sectional study was conducted in the diabetes center at King Fahd Specialist Hospital and the primary health care centers in Tabuk City, Saudi Arabia, from December 2021 to November 2022.

The diabetes center was chosen because it is the only center in Tabuk and serves approximately 5,000 patients with diabetes mellitus. The center is well structured; endocrinologists, family medicine, general practitioners, dietitians, diabetes educators, and nurses provide diabetes care with a referral system to other specialties in the hospital. In addition, there are diabetes primary health care centers distributed in the different regions of the city with referrals to the center. A simple random technique was used to choose three centers in Tabuk City.

Inclusion and Exclusion Criteria

Patients aged ≥55 years with diabetes mellitus were included; younger age groups and pregnant women were excluded from the study.

Sample Size Calculation

Two hundred and six consecutive patients were included. The sample size was calculated using the formula: Sample size= $Z\ X^2\ P- Q/d^2$ Where X=constant value (1.96) at 95% confidence, P=prevalence of diabetes mellitus in Saudi Arabia, Q=1-Prevalence and d=tolerated error=0.05

Measures

A structured questionnaire was administered to assess sociodemographic data, diabetes duration, and associated comorbidities including hypertension and dyslipidemia, and HbA1c, and diabetes self-care activities. Additionally, the Mini-Cognitive Assessment Questionnaire and the HADS were administered. The principal investigator and the third and fourth authors administered the questionnaires *via* face-to-face interviews.

Diabetes Self-Care Activity Assessment

The Arabic Summary of Diabetes Self-Care Activities questionnaire has been previously validated for use in Saudi Arabia[16] with acceptable psychometric properties (test-retest, r=0.912, Cronbach's alpha=0.76, *p*-value, 0.01).

Relevant aspects of diabetes self-care include knowledge about diet, exercise, smoking status, blood glucose monitoring, foot care, and adherence to medications. The questionnaire assessed five dimensions. Sick patients were asked to answer the questions while considering the seven days prior to become sick. The first dimension assessed whether the respondent followed a healthy diet, the days/week of adhering to that diet, whether they eat five or more servings of fruits and vegetables, and the number of days that fatty food was consumed. The second dimension assessed how many days the patient exercised for 30 minutes or more, specific activity sessions, and the type, duration, and level of exercise. The third dimension assessed the number of days in which blood glucose was measured and whether the patient adhered to several tests recommended by the treating doctor. The fourth dimension assessed foot care (the number of feet inspection and inside the shoe inspections). The fifth dimension assessed whether the respondent smoked in the last week and the number of cigarettes, if any. In addition, the questionnaire assessed the type and number of diabetes medications used and the number of days the patients adhered to medication use.

Cognitive Impairment Assessment

The Mini-Cog© (Washington, USA) was used for cognitive evaluation; it is a two-part assessment tool with a total score of five, including three points for three recalls and two points for clock drawing. The clock numbers must be completely drawn in the right direction with the arms at ten past eleven[17,18]. A score of two indicates that the correct numbers and arms. The length of the arms is not assessed. A score of zero indicates that the clock is drawn incorrectly. The Mini-Cog© has been previously validated for use among elderly patients, with a score of 0-2 indicating high sensitivity in both primary care and hospital settings[19,20].

Depression Evaluation

The HADS inventory for depression is a seven-item scale, with four responses with no (zero) and three maximal responses. The items assess whether the respondent still enjoys things that they used to enjoy; whether the respondent can laugh; whether the respondent feels cheerfulness; whether the respondent has slowed down; whether the respondent has lost interest in their appearance; whether the respondent looks forward to enjoyment; and whether the respondent can enjoy a good book, radio, or television. The Arabic version of the questionnaire has been previously validated to assess depression in various hospital settings, including emergencies[21,22].

Ethical Considerations

Patient privacy was insured according to the Helsinki declaration. The participants signed written informed consent. The information reported was approached confidentially with no identity. The patients were assured that the data of concern would be used only for this research. Ethical approval was obtained from the Ethical Committee of the University of Tabuk and the Directorate General of Health Affair in Tabuk City. The draft questionnaire and master sheet were kept for future checks.

Statistical Analysis

The Statistical Package for Social Sciences version 20 (IBM Corp., Armonk, NY, USA) was used for data analysis. The data are presented as the mean±SD and percentages unless otherwise specified. Logistic regression analysis was used to assess the relationship between cognitive decline and diabetes self-care activities. A *p*-value <0.05 was considered significant.

Results

There were 206 patients with diabetes (63.1% women); 55.9% were taking insulin, 59.1% were taking metformin, and 14.1%, 6.3%, 1.4%, and 4.9% were taking sulfonylureas, glucagon-like peptide agonists, sodium-glucose cotransporter inhibitors, and dipeptidyl peptidase inhibitors, respectively. The most common comorbidity was dyslipidemia (59.8%), followed by hypertension (55.9%) and depression (24.3%). Mild cognitive decline was reported in 51.5% of patients (Table I).

In this study, the age of the participants was 59.65±9.43 years, the glycated hemoglobin was 8.88±2.01, the duration of diabetes was 13.91±9.35, and the patient scored 35.30±13.88 in daily self-care activity. Table II depicts the patients' basic characteristics.

Mild cognitive impairment was negatively correlated with HbA1c and daily diabetes self-management activities (odds ratio, 0.750, 95% CI, 0.56-1.00, *p*-value, 0.055, and odds ratio, 1.21, 95% CI, 0.99-1.08, *p*-value, 0.081, respectively). No significant relationship was found between mild cognitive impairment and the duration of diabetes, depression, or dyslipidemia (odds ratio, 1.02, 95% CI, 0.95-1.09, *p*-value, 0.497, odds ratio, 1.21, 95% CI, 0.32-4.57, *p*-value, 0.777, and odds ratio, 2.51, 95% CI, 0.76-8.30, *p*-value, 0.13, respectively). Table III illustrates the relationships between cognitive impairment and other patient characteristics.

Discussion

Diabetes mellitus is associated with a 50% increase in the risk of dementia risk, and type 2 diabetes mellitus increases the risk of dementia by 19% over 20 years[23]. We found a mild cognitive decline in 51.5% of the participants, and the current findings were similar to a previous study conducted in India[24] that reported that the prevalence of mild cognitive decline was 54.29% among DM patients. The present results were slightly lower than a recent study[25] published in India, which reported a prevalence of 63.8%. The higher rate of cognitive decline is alarming and might initiate a vicious circle of diabetes in which cognitive impairment negatively impacts diabetes self-care, leading to poor glycemic control and thereby increasing diabetes complications. A study[26] from China reported a lower prevalence than our findings. In the present study, no significant association was found between mild cognitive decline and depression, which contradicts previous studies[27]. The association of cognitive line with age is obvious; a previous study[28] found that the effect of diabetes on cognition is more profound

Table I. Basic characteristics of the study group.

Character	No %
Gender	
Males	76 (36.9%)
Females	130 (63.1%)
Drugs	
Insulin	114 (55.9%)
Metformin	122 (59.8%)
Sulfonylureas	30 (14.7%)
Glucagon-like peptide agonists	13 (6.3)
Sodium-glucose cotransporters inhibitors	3 (1.4%)
Dipeptidyl peptidase inhibitors	10 (4.9%)
Hypertension	120 (55.3%)
Dyslipidemia	114 (55.9%)
Depression	50 (24.3%)
Mild cognitive impairment	106 (51.5%)
Smoking	38 (18.4%)
Adherence to medications	180 (87.4%)

Table II. Age, HbA1c, duration of diabetes, cognitive score, and diabetes self-care activities scores of the study group.

Character	Mean±SD
Age	59.65±9.43
Duration of diabetes	13.91±9.35
HbA1c	8.88±2.01
Daily activity score	35.30±13.88
Exercise score	5.17±5.06
Glucose monitoring score	6.09±5.87
Foot care score	9.33±5.86
Diet score	14.69±7.50
Cognitive score	3.00±1.76

Table III. The associations of mild cognitive impairment, age, sex, oral hypoglycemic drugs, hypertension, dyslipidemia, daily self-management activities, and depression.

Character	Wald	df	95% CI	*p*-value
Gender	2.24	0.415	0.13-1.31	0.134
Age	18.14	0.832	0.76-0.991	0.000
Duration of diabetes	0.46	1.02	0.95-1.09	0.497
HbA1c	3.69	0.750	0.56-1.00	0.055
Insulin	0.12	1.29	0.29-5.63	0.729
Metformin	1.32	0.386	0.7-1.94	0.249
Sulfonylureas	1.13	0.403	0.07-2.15	0.287
Hypertension	1.70	2.26	0.66-7.72	0.192
Dyslipidemia	2.29	2.51	0.76-8.30	0.130
Daily activity score	3.04	1.03	0.99-1.08	0.081
Depression	0.08	1.21	0.32-4.57	0.777
Constant	13.74	593221.3		0.000

Binary logistic regression.

in middle age as opposed to the elderly in agreement with the current findings. The above findings imply that screening for cognitive dysfunction must be started earlier to prevent its negative effects in later life. In addition, subtle cognitive changes might be passed unnoticed by the patients and the treating physician. Our results showed no relationship between cognitive decline and antidiabetic medications, similar to previous studies[29-32] that found no association between exenatide, basal insulin, and metformin and cognitive decline. We reported higher glycated hemoglobin among patients with cognitive impairment but did not reach statistical significance; this is consistent with the findings of Xu et al[33] who found non-linear association between cognitive decline and HbA1c, supporting a previous observation[34]. A study conducted by Cuevas and Stuifbergen[35] showed negative effects of cognitive decline and duration of diabetes on diabetes self-care activities. In the present study, poor cognition was associated with lower diabetes care activities, but this association was not statistically significant. Plausible explanations might be the small sample size and the different methods of evaluating cognitive decline. The crosstalk between cognition and diabetes self-care is complex and multidirectional and depends on the tests used to assess cognitive impairment. Some scholars[37] found a relationship, and others found the opposite[36]. In addition, Nguyen et al[38] considered that self-care behavior moderates the relationship between cognition and glycated hemoglobin. A recent systematic review and meta-analysis[39] found a higher rate of depression among patients with diabetes (22% *vs.* 13% for type 1 diabetes and 19% *vs.* 11% for type 2 diabetes). We reported a higher prevalence (24.3%) than the previous observations[39]. The higher rate of depression is alarming and needs urgent intervention in terms of screening and treatment. Another recent meta-analysis[40] found an association between depression and cognitive decline. We did not find a relationship between depression and cognitive decline, contradicting the previous findings[40]. Importantly, the previous meta-analysis[40] included only one study that assessed mild cognitive decline, which assessed depression among elderly patients with type 2 diabetes and used a different method for evaluation of MCI[41]. In the present study, the conservative community in Saudi Arabia might explain the low rate of smoking among the study group (18.4% *vs.* 33.9% in Sudan)[42]. The higher diabetes activity score can be explained by the fact that nearly half of the participants received family support from their sons and daughters (data not shown). Our findings are unique because we assessed mild cognitive impairment associated with depression and diabetes self-care activities.

The current result should be viewed in light of the small sample size; the study was conducted at a single tertiary care center. Thus, our results cannot be generalized to the whole country. Further larger multicenter studies are needed.

Conclusions

Mild cognitive impairment, depression, hypertension, and dyslipidemia were common among patients with diabetes in Tabuk, Saudi Arabia. Mild cognitive impairment was associated with age. No association was found between MCI and DSCA, dyslipidemia, hypertension, or duration of diabetes. Larger multicenter studies using objective measures to assess mild cognitive decline are recommended.

Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethics Approval

The Ethical Committees of the University of Tabuk and the Directorate General of Health Affairs, Tabuk City, Saudi Arabia approved the research (ref. number, UT-183-45-2022, dated 8-3-2022).

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Informed Consent

Informed consent was obtained from all subjects involved in the study.

Availability of Data and Materials

The data of the current study are available from the corresponding author upon request.

Authors' Contributions

H. Mirghani, the concept and design, data analysis, and manuscript drafting. A. Albalawi, A. Alqrid, and A. Almutiri: data collection, interpretation, and manuscript drafting. All the authors revised the manuscript critically and approve it before submission.

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