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ORIGINAL RESEARCH

Relationship Between Self-Care Behavior and Cognitive Function in Hospitalized Adult Patients with Type 2 Diabetes: A Cross-Sectional Study

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Purpose: To investigate the relationship between diabetes self-care behavior and cognitive function of hospitalized young and middle-aged Chinese patients with type 2 diabetes mellitus (T2DM).

Patients and Methods: In this cross-sectional study, young and middle-aged T2DM patients (age range, 35–65 years) were recruited at 4 tertiary hospitals between July 2016 and January 2017. Data pertaining to self-care behavior and cognitive function were collected using two questionnaires (the Summary of Diabetes Self-care Activities [SDSCA] and the Montreal Cognitive Assessment [MoCA], respectively). Multivariate linear regression analysis was performed to assess the correlation between cognitive function and self-care activities.

Results: A total of 140 patients with diabetes were enrolled (mean age, 53.79±7.96 years). The mean duration of T2DM was 10.83±6.76 years. Regarding SDSCA performance, the mean scores for foot care and blood glucose monitoring were 2.20±2.57 and 1.98±2.45, respectively, which were the worst; scores for exercise (4.01±2.58) and diet (3.16±1.89) were better, while scores for medication administration (5.26±2.79) were the best. The prevalence of cognitive impairment was 37.9% (53 patients). After variables adjustment, delayed recall showed a significant correlation with blood sugar monitoring behavior (B =0.224, P=0.019); visual space and executive function (B=0.255, P=0.009) and abstraction (B=−0.337, P=0.001) showed a correlation with foot care behavior.

Conclusion: Cognitive ability affects the self-care behavior of patients with T2DM. Assessment of cognitive function may help inform patient education interventions to improve the self-care behavior of these patients.

Keywords: young and middle-aged, cognitive impairment, self-care behaviors, type 2 diabetes mellitus

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Introduction

Type 2 diabetes mellitus (T2DM) is a major health issue and a primary cause of mortality across the world.[1,2] The condition is also referred to as adult-onset diabetes as it typically occurs in the middle- and late adulthood.[3,4] More than 4 million people are affected by T2DM annually worldwide, which imposes a considerable economic burden on the patients and the society.[4] In addition, T2DM decreases the life expectancy of people who have the disease by about 15 years.[5] In 2010, the reported prevalence of diabetes among Chinese adults was approximately 11.6%.[6]

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Self-care behavior in the context of diabetes refers to actions taken by patients to deal with their disease based on their knowledge and skills; these include physical activity, healthy diet plan, self-monitoring of glucose level, and adherence to medication.[7] Self-care behavior of patients with diabetes has a positive impact on achievement of glycemic control and can reduce the risk of cardiovascular complications by 80%.[8,9] Diabetes may accelerate cognitive aging and is a risk factor for cognitive dysfunction.[9] In addition, cognitive dysfunction can affect the self-care behavior of patients with diabetes. As self-care behavior is important for diabetes management, characterization of its relationship with cognitive dysfunction is a key imperative.

Diabetes is associated with cognitive change because it may influence some of the cognitive changes. At the same time, diabetes self-management tasks require multiple cognitive skills. Several studies have focused on the relationship between cognitive dysfunction and self-management of diabetes in older people. For instance, cognitive dysfunction showed an association with worse self-care behavior or caused unreasonable diabetes self-care behavior, such as they do not know what to do in the event of low blood sugar or how to manage medication in the event of sickness.[10–12] Cognitive dysfunction has an adverse effect on self-care behavior, while poor glycemic control has also been shown to be a risk factor for cognitive dysfunction.[13,14]

Middle-aged patients with T2DM were found to exhibit a certain degree of cognitive dysfunction.[15,16] However, the impact of cognitive dysfunction on the self-care behavior of young and middle-aged adult patients is not well characterized. The objective of this study was to examine the relationship between cognitive dysfunction and self-care behavior in a sample of Chinese adult patients with diabetes aged 35–65 years. This age-group represents the predominant segment of the Chinese workforce. We hypothesized that among patients with T2DM, those with more severe cognitive dysfunction would exhibit worse behavior pertaining to their diabetes self-care management.

Methods

Study Design and Patients

This was a cross-sectional study. The study protocol was approved by the Peking University Institutional Review Board and the ethics committee at each of the participant hospitals. The purpose of the study was explained to the participants, and written informed consent was obtained prior to their enrolment.

From July 2016 to January 2017, consecutive patients with T2DM who qualified the eligibility criteria were enrolled at the Peking University Third Hospital, the Peking University People's Hospital, Peking University First Hospital, and the Beijing Haidian Hospital. The inclusion criteria were: 1) patients aged 35–65 years who were diagnosed based on the 1999 WHO diagnostic criteria for diabetes;[16] 2) duration of diabetes: more than 1 year; 3) education level: primary school and above. The exclusion criteria were 1) patients with malignant tumor or severe heart, lung, or kidney disease; 2) history of cerebrovascular disease; 3) history of any other disease that can lead to central nervous system damage, such as trauma, tumor, or infection; 4) patients with major depression, schizophrenia, or dementia; 5) patients with impaired ability for hearing, reading, or writing and those with difficulty in language expression; 6) patients with impaired ability to take care of themselves.

Measures

Demographic and Clinical Characteristics

Data pertaining to following variables were collected: 1) demographic variables, including sex, age, level of education, body mass index (BMI), long-term residence, marital status, occupation, and average monthly income per person of their family; 2) clinical variables disease, including the duration of diabetes, current treatment, glycosylated hemoglobin level, history of symptomatic/severe hypoglycemia, concomitant diseases, and complications of diabetes.

The Summary of Diabetes Self-Care Activities (SDSCA)

The SDSCA scale is a self-report quantitative measure of diabetes self-care. The scale was originally developed by Toobert et al in 1994 and its validity and reliability is well documented[17–19] Wan et al translated it into Chinese in 2008.[19] The scale consists of 11 items that cover the self-care behavior in the context of diabetes including assessment of diet (general and specific), blood sugar monitoring, exercise, foot care, and cigarette smoking. Each item has a minimum score of 0 and a maximum score of 7, based on which the scores for each dimension were the summary of scores for every item, the mean score for each dimension was calculated using the formula: actual scores for each

dimension/numbers of items. The total score range for SDSCA is 0–77. The higher the score is, the better the self-care is.

The scale has a good structural validity. The overall Cronbach's α of SDSCA is 0.62 (test–retest reliability: 0.8; Kaiser-Meyer-Olkin (KMO) value: 0.64).

Montreal Cognitive Assessment (MoCA)

MoCA is a widely used scale to screen for mild cognitive impairment. Several versions of the scale are currently available.[20,21] We used the Chinese version, which includes seven dimensions, namely visual space and execution ability, naming, attention, language, abstraction, memory and delayed recall, and orientation.[19] The total score range is 0–30 points; a score of ≥26 points was defined as normal cognition while a score of <26 points was considered indicative of cognitive dysfunction (mild cognitive impairment). The higher the score, the better is the cognitive function.

Dimensional analysis of the scale has been performed, and each cognitive domain is delineated as a functional abnormality in the domain.[11,12] If the subject has received education for ≤12 years, the total score is increased by 1 to correct the impact of the education level. The Cronbach's α scale of MoCA was 0.818. MoCA has been shown to exhibit 90% sensitivity and 87% specificity for screening for mild cognitive impairment.[21]

Procedure

A trained diabetes nurse educator collected the essential clinical information of patients and completed the cognitive function scales. After obtaining written informed consent, the participants were invited to a comfortable and quiet reception room for data collection. First, the patient filled up a demographic questionnaire, and then the diabetes nurse educator conducted the SDSCA survey and MoCA assessment. Other disease-related information was collected from the inpatient medical records.

Statistical Analysis

The data were entered and analyzed using SPSS20.0 statistical software (SPSS Inc., Chicago, IL, USA). Normally distributed continuous variables are expressed as mean ± standard deviation (SD), and categorical variables are expressed as frequency and percentage. The association between groups were analyzed by one-way analysis of variance (ANOVA) or Pearson Chi-squared test. Multivariate linear regression analysis was performed to assess the correlation between cognitive function and self-management behavior of patients. Variables that showed a significant association with cognitive function on univariate analysis were treated as covariates in the multivariate regression analysis. Using the forward stepwise regression, 0.05 was set as the inclusion criteria to analyze the correlation between the dimensions of self-care behavior and the cognitive function. *P* values <0.05 were considered indicative of statistical significance.

Results

Clinical Characteristics of Patients

A total of 140 young and middle-aged patients with T2DM were enrolled. The mean age of patients was 53.8±7.9 years. The mean duration of diabetes was 10.83±6.8 years. The complications in this study cohort included hypertension, hyperlipidemia, coronary heart disease, retinopathy/cataract, peripheral neuropathy, and diabetic foot. Only 11 participants (7.9%) were found using only lifestyle interventions for the treatment of diabetes. Mild cognitive impairment was found in 53 (37.8%) patients (Table 1).

SDSCA

The self-report SDSCA survey showed that 5.7% (8/140) patients had good self-care behavior, 46.7% (65/140) patients had medium self-care behavior, and 47.9% (67/140) patients had poor self-care behavior.

Among all the self-care behavioral dimensions, the mean scores for foot care and blood glucose monitoring were 2.20 ±2.57 and 1.98±2.45, respectively, which were the worst; scores for lifestyle management including exercise (4.01 ±2.58) and diet (3.16±1.89) were better, while scores for medication administration (5.26±2.79) were the best (Table 2).

MoCA Assessment Results and Univariate Analysis of Mild Cognitive Impairment

In this study, 37.9% (53/140) patients had mild cognitive impairment. With respect to various dimensions of cognitive function (from high to low), 85.0% (119/140) patients had delayed recall function, 3.6% (103/140) had impaired language function, 50.7% (71/140) had impaired visuospatial ability and executive function, 18.6% (26/140) had impaired attention function, 11.4% (16/140) had impaired abstract function, and 11.4% (16/140) had impaired orientation function. On univariate analysis, age (t/χ^2=−4.53, P=0.001), years of schooling (t/χ^2=2.40, P=0.018), and duration of diabetes (t/χ^2=−3.08, P=0.002) were associated with mild cognitive impairment (Table 3).

Table 1 Basic Characteristics of the Study Population (n=140)

Variables	Male (n=90)	Female (n=50)
Age (years), mean±SD	53.09±8.0	54.96±7.7
Years of schooling, mean±SD	13.76±3.9	13.56±2.6
BMI (kg/m^2), mean±SD	25.35±2.98	26.00±3.41
Duration of diabetes (years), mean ±SD	11.12±6.9	10.30±6.4
HBA1C, mean±SD	8.69±1.98	9.42±1.70
Event number of hypoglycemia, n (%)	41 (45.6)	27 (54.0)
Complications, n (%)		
Hypertension	45 (50.0)	23 (46.0)
Hyperlipidemia	53 (58.9)	29 (58.0)
Coronary heart disease	7 (7.8)	1 (2.0)
Retinopathy/cataract	13 (14.4)	8 (16.0)
Peripheral neuropathy	14 (15.6)	3 (6.0)
Diabetic foot	3 (3.3)	1 (2.0)
Diabetes treatment, n (%)		
Lifestyle intervention	6 (6.7)	5 (10.0)
Only by oral medication	41 (45.6)	20 (40.0)
Insulin	7 (7.8)	4 (8.0)
Oral medication + Insulin	36 (40.0)	21 (42.0)
*Mild cognitive impairment, n (%)		
Yes	29 (32.2)	24 (48.0)
No	61 (67.8)	26 (52.0)

Note: There are no significant differences between men and women. *Based on the Montreal Cognitive Assessment (MoCA).
Abbreviations: SD, standard deviation; BMI, body mass index; HBA1C, hemoglobin A1C.

Table 2 Summary of Diabetes Self-Care Activities (SDSCA) of the Study Population (n=140)

Dimensions	Number of Items	Scores	Mean Score*
Total	11	34.29±16.70	3.12±1.52
Diet	4	12.66±7.57	3.16±1.89
Exercise	2	8.02±5.16	4.01±2.58
Blood-glucose monitoring	2	3.95±4.91	1.98±2.45
Footcare	2	4.40±5.14	2.20±2.57
Medications	1	5.26±2.79	5.26±2.79

Note: *mean score = scores/numbers of items.

The Association of Each Dimension of Self-Care Behavior with Cognitive Function

Based on the results of univariate analysis, age, sex (0=male, 1=female), years of schooling, duration of diabetes, hemoglobin A1C (HBA1C), and treatment (0=oral medication, 1=oral medication + insulin) were included as covariates in the multiple stepwise regression. The results showed no significant correlation of cognitive function with lifestyle (diet, exercise) management, or medication management. However, delayed recall was associated with blood glucose monitoring (B=0.224, P=0.019), while visual space and executive function (B=0.255, P=0.009) and abstract (B=−0.337, P=0.001) were related to foot care (Table 4).

Discussion

Diabetes is a chronic metabolic disease characterized by chronic hyperglycemia. The self-management level of patients with diabetes directly affects the quality of integrated diabetes management.[5] Among the dimensions of self-care behaviors assessed in this study, the drug management score was the highest; this may be attributable to the good therapeutic effect of hypoglycemic drugs, which helps improve the patient's medication compliance.[22–25] Poor diet and exercise management indicate room for further improvement in the lifestyle management of young and middle-aged T2DM patients.[26,27] Poor foot care was consistent with the results of most previous studies in China.[24] In addition, the scores for blood glucose monitoring were the lowest (3.95±4.91); in previous studies conducted in other countries, the average blood glucose monitoring score was about 6.0.[28,29] Many patients in this study performed blood glucose testing only when they were seeking medical treatment or feeling unwell, which indicates poor compliance of patients with blood glucose monitoring.[30] In addition to the health management education provided by physicians or educators, the relationship between patient cognitive function and self-care behavior should be explored, especially with regard to lifestyle, foot care, and blood glucose testing.[10] The prevalence of cognitive impairment in our study was 37.9%, which showed that even in young and middle-aged T2DM patient, middle cognitive impairment was still an important issue; age, years of schooling, and duration of diabetes showed a significant correlation with mild cognitive impairment in young and middle-aged T2DM patients. We found that only 15.0% of hospitalized patients with T2DM showed good self-care behavior. The best performance among the various self-care behavioral domains was with respect to medication management, followed by diet and exercise management and blood glucose monitoring, while the worst performance was with respect to foot management. These findings are consistent with those of previous studies conducted among older people with T2DM in China.[22,23,31–33] In summary, this study found

Table 3 Results of Univariate Analysis of Mild Cognitive Impairment (Categorical Variables) (n=140)

Variable	Mild Cognitive Impairment (n=53)	Normal Cognition (n=87)	t/χ^2	*P*
Age (years)	57.4±6.1	51.5±8.1	−4.53	0.001
Sex (%)			3.40	0.065
Male	29 (32.2)	61 (67.8)		
Female	24 (48.0)	26 (52.0)		
Years of schooling (years)	12.87±3.26	14.18±2.96	2.40	0.018
Duration of diabetes (years)	13.02±7.45	9.49±5.96	−3.08	0.002
HBA1C (%)	9.23±1.98	8.91±1.82	−0.96	0.341
Diabetes treatment			6.10	0.107
Lifestyle intervention	1 (9.1)	10 (90.9)		
Only by oral medication	28 (45.9)	33 (54.1)		
Insulin	3 (27.3)	8 (72.7)		
Oral medication + Insulin	21 (36.8)	36 (63.2)		
Self-care behaviors				
Diet	3.10±1.95	3.27±1.80	−0.51	0.611
Exercise	4.34±2.56	3.81±2.58	−1.18	0.241
Blood-glucose testing	2.25±2.54	1.81±2.40	−1.02	0.311
Foot care	2.50±2.67	2.02±2.51	−1.08	0.283
Medications	5.40±2.78	5.18±2.80	−0.44	0.664

Note: t/χ^2 is the statistic of univariate analysis.

poor self-management behavior of young and middle-aged patients with T2DM, which calls for concerted interventions involving diabetes educators.

The MoCA is a highly sensitive screening tool for mild cognitive impairment in older adults, and is also used in young to middle-aged adults.[34–36] The cognitive function dimensions of diabetes self-management behaviors were mainly delayed recall, visuospatial abilities and executive function, and abstract. Among those dimensions, delayed recall was significantly related to blood glucose monitoring (P=0.019), while visuospatial abilities and executive functions (P=0.009) and abstract ability (P=0.001) were significantly associated with foot care. Delayed recall refers to impaired ability to recall past events. This study found that the better the patient's delayed recall, the better was the blood glucose monitoring; this finding was consistent with those reported by Compeán-Ortiz et al, who assessed 105 patients with middle-aged T2DM using the Wechsler Memory Scale and SDSCA scale.[37] However, Primožič et al found that delayed recall was not associated with self-management behavior.[29] Furthermore, Li et al used the SDSCA scale and the auditory word learning test (AVLT) to measure the self-management behavior and memory function of 51 middle-aged T2DM patients; the results showed that the worse the delayed recall, the better was the self-management behavior.[23] This discrepancy may be attributable to differences with respect to the characteristics of the study cohorts and the screening tools. Visuospatial abilities and executive functions (alternating lines, cubes, clocks) refer to the general control mechanisms for the coordination and execution of complex cognitive tasks; these ensure that the cognitive systems implement specific goals in a flexible and optimized manner.[38] A meta-analysis conducted by Tomlin et al found that implementation dysfunction may cause a decline in the self-management ability of patients with diabetes.[11] In this study, we found that the better the visuospatial abilities and executive functions of the young and older patients, the better was their foot care. Primožič et al assessed 98 older people with T2DM; they found a significant association of visuospatial abilities and executive functions with self-management behavior (the better the visuospatial abilities and executive functions, the better were the patient's self-management behaviors). In our study, the better the abstract ability, the worse was the foot care; to the best of our knowledge, no other study has found this association. The clinical relevance of this

Table 4 Results of Multivariate Regression Analysis Showing the Association of Each Dimension of Self-Care Behaviors with Cognitive Function (n=140)

Variables	Multivariate Regression	
	β_{adj} (95% CI)	P
Diet		
Visuospatial abilities and executive function	0.017 (−0.420–0.501)	0.862
Attention	−0.067 (−1.062–0.507)	0.484
Abstract	−0.144 (−1.379–0.213)	0.149
Delayed recall	0.141 (−0.058–0.416)	0.138
Language	0.121 (−0.159–0.716)	0.210
Exercise		
Visuospatial abilities and executive functions	−0.035 (−0.778–0.561)	0.749
Attention	−0.105 (−1.714–0.566)	0.321
Abstract	−0.127 (−1.837–0.476)	0.246
Delayed recall	−0.031 (−0.397–0.293)	0.765
Language	0.036 (−0.527–0.745)	0.734
Medications		
Visuospatial abilities and executive functions	−0.042 (−0.714–0.451)	0.655
Attention	0.113 (−0.363–1.620)	0.211
Abstract	0.129 (−0.303–1.708)	0.169
Delayed recall	0.085 (−0.155–0.444)	0.341
Language	−0.071 (−0.774–0.332)	0.430
Blood Sugar Testing		
Visuospatial abilities and executive functions	−0.024 (−0.656–0.517)	0.814
Attention	−0.150 (−1.789–0.207)	0.119
Abstract	−0.050 (−1.274–0.751)	0.610
Delayed recall	0.224 (0.062–0.666)	0.019
Language	0.034 (−0.458–0.656)	0.725
Foot Care		
Visuospatial abilities and executive functions	0.255 (0.204–1.413)	0.009
Attention	0.059 (−0.694–1.364)	0.520
Abstract	−0.337 (−2.916–0.828)	0.001
Delayed recall	0.151 (−0.048–0.575)	0.096
Language	0.073 (−0.345–0.803)	0.431

Note: Covariates: age, sex (0=male, 1=female), years of schooling, duration of diabetes, HBA1C, treatment (0=oral medication, 1=oral medication + insulin)
Abbreviation: CI, confidence interval.

finding is that patients who have excellent abstract ability should be better educated about the need for feet examination. The evidence obtained from this study highlights the need for assessment of the cognitive function of patients with T2DM, for example, through face-to-face teaching of physicians and educators during hospitalization, and using informational means outside the hospital (APP management platform, etc.) in order to optimize patient management.

To the best of our knowledge, the correlation between cognitive function and self-care ability has not been previously assessed in Chinese hospitalized young and middle-aged T2DM patients. However, it is important to acknowledge that some limitations of this study should be considered while interpreting the results. First, the study population comprised of inpatients at four tertiary hospitals in Beijing; secondly, the sample size was relatively small, which limits the generalizability of our findings. Research in the community-based young and middle-aged T2DM population and the use of a larger sample size is required to determine more definitive evidence of the impact of cognitive function on diabetes self-care behavior. Furthermore, the Cronbach's α value of the Chinese version of SDSCA (the most widely used in China) is low, which may have affected the accuracy of cognitive function assessment to some extent.

Conclusion

In summary, the self-care behavior of young and middle-aged Chinese patients with T2DM was found to be suboptimal. Some dimensions of the cognitive function including delayed recall, visuospatial abilities and executive functions, and abstract ability showed a significant direct association with self-care behavior. These findings suggest the need to educate young and middle-aged T2DM patients and to monitor their cognitive rehabilitation and self-care behavior to help improve the quality and level of diabetes management.

Ethics Approval and Informed Consent

This clinical trial was approved by the Ethics Committee of Peking University, and has been performed according to the ethical standards laid down in the 1964 Declaration of Helsinki. Informed consent was written by all individual participants included in the study.

Data Sharing Statement

The data used to support the findings of this study are included in the article.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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