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ORIGINAL RESEARCH

Path Analysis of Influencing Factors of Depression in Middle-Aged and Elderly Patients with Diabetes

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Purpose: This study aimed to assess the prevalence of depression in middle-aged and elderly patients with diabetes in China, determine the risk factors of depression in these patients, and explore the internal relationship between influencing factors and depression by constructing a pathway model.

Methods: Data were collected from the 2018 China Health and Retirement Longitudinal Study (CHRLS). We included 1743 patients with diabetes who were assessed using the CES-D10, which is used to measure depressive symptoms in Chinese older adults. Based on the theory of psychological stress, data were analyzed using SPSS software version 22.0 and MPLUS 8.0. A correlation analysis was used to explore the relationship between the variables and depression scores. A path model was constructed to explore the interrelationships between variables and verify the relationships between variables and depression in patients with diabetes.

Results: The prevalence of depression among patients with diabetes was 42.5%. The path analysis results showed that income, diabetes duration, sleep duration, pain distress, self-rated health, and glycemic control directly affected depression, and self-rated health had the largest effect value. With self-rated health and glycemic control as mediator variables, income, diabetes duration, sleep duration, pain distress, glycemic control, and insulin use had indirect effects on depression by influencing self-rated health. Age, frequency of blood glucose monitoring, and exercise glycemic control awareness indirectly affected depression by affecting glycemic control, self-rated health status, and depression.

Conclusion: We found that the path analysis model could construct the interaction between the influencing factors and explore the potential interrelationship between the influencing factors and diabetes-related depression. Patients with diabetes must adhere to regular medication, maintain a healthy lifestyle, and have effective glycemic control. Diabetes depression can be effectively prevented by making psychological knowledge publicly available, providing health education, and establishing corresponding for diabetes.

Keywords: diabetes, depression, influencing factors, path analysis

Introduction

The number of diabetes mellitus (DM) cases is rising globally. According to the International Diabetes Federation's Diabetes Atlas (IDF) for 2021, 537 million adults are living with diabetes, ie, 1 in 10. Predictions are that this number will rise to 643 million by 2030 and 783 million by 2045. According to the IDF, China is the largest developing country in the world and has a serious aging population, which faces a more severe risk of diabetes. The prevalence of diabetes in China increased from 8.8% in 2011 to 10.6% in 2021, which is expected to increase by 11.8–12.5% from 2030 to 2045. The number of patients with diabetes is expected to increase from 140 million in 2021 to 164 million in 2030 and 1.74 million by 2045. China is now the country with the highest number of patients with diabetes worldwide.[1]

Owing to the complicated conditions and the long duration of diabetes, they need to take long-term medication to maintain stable glycemic control and change eating behaviors, such changes may lead to reduced quality of life for the individual as well as higher costs for society. Furthermore, diabetes complications and treatment-associated side effects can negatively affect their physical and mental health and increase the risk of depression.[2] People with Type 2 diabetes are more likely to experience elevated depression than people without diabetes[3] and are twice as likely to struggle with depressive symptoms than people without diabetes.[4] However, the prevalence of depression among patients with diabetes

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varies. In Ethiopia, the prevalence of depression among people with diabetes ranges from 13% to 40.4%[5,6] and from 20.6% to 48.7% in different regions of Saudi Arabia.[7,8] Previous studies have shown that the prevalence of type 2 diabetes combined with depression in China is between 10% and 50%.[9–14] On the whole, depression is more prevalent in developing countries, with a survey showing that the prevalence of depression in diabetes rose from 34% to 54%.[15–17] Moreover, people with depression seem to be more prone to developing an associated DM. A study found that depression can worsen glycemic control in diabetes, with a higher risk of developing complications and adverse outcomes.[18]

Diabetes and depression are among the top ten causes of death worldwide. Therefore, the coexistence of depression and diabetes will result in a high disease burden, high disability rate, and high fatality rate, bringing a serious burden to society. There are also negative impacts on lifestyle and quality of life, such as poorer clinical outcomes, impaired self-management, and higher medical costs. Therefore, it is particularly important to consider depressive comorbidities in patients with diabetes.

Diabetes is one of the most common chronic diseases in China, and as the country with the largest population of diabetics,[1] we need to pay more attention to patients'disease control and mental health status. Previous studies on depression in diabetic patients mostly included hospitalized patients or chronic patients from certain communities, with few large national survey objects.[19,20] The current study used the CHARLS database, which is more representative. Previous studies have used univariate factors and regression analysis to identify the association between risk factors and diabetes depression. The results showed that the incidence of depression in patients was correlated with female gender, divorce, age, low education level, disease duration, blood glucose control, diet control and exercise adherence, insulin treatment, and the number of diabetes complications.[19–21] Few studies have explored the interactions between influencing factors. Path analysis is a method to study the complex relationships between multiple variables. This solves the deficiency in which the traditional regression model can only analyze a single dependent variable. By analyzing the direct or indirect effects between the research variables and outcome variables, we calculate the size of the direct, indirect, and total effects of the derived variables on the dependent variables through the path coefficient. At the same time, the interaction between the variables is more clearly shown in the path diagram. Therefore, this study used path analysis to explore the factors that influence depression in patients with diabetes."Self-rated health"and"blood glucose control"are used as mediating variables to explore the stress response to other stressors and other variables through the interaction of mediating variables.

Methods

Data Sources

The China Health and Retirement Longitudinal Study (CHARLS)[22] is a nationally representative household survey conducted by Peking University on the Chinese population. The CHARLS collected high-quality data of people aged 45 and above from 28 provinces, municipal cities, and autonomous regions. This study selected the data from the CHARLS 2018 database. CHARLS was reviewed and approved by the Ethics Review Committee of Peking University. The ethics committee of this study was (IRB00001052-11015). Informed consent was obtained from all participants. This study was approved by the Science and Technology Ethical Committee of the First Affiliated Hospital of Shihezi University School of Medicine (KJ2021-135-01). The sample data of patients with diabetes and abnormal or missing data of core variables were excluded, and 1743 middle-aged and elderly patients with diabetes were finally selected.

Assessment of Depression Symptoms

Depressive symptoms were assessed using the Chinese version of the 10-item Center for Epidemiologic Studies Depression Scale (CES-D10), validated and used to measure depressive symptoms in Chinese older adults. This simple 10-item self-rating (CES-D) was used to calculate the score. Each question is assigned a score of 0, 1, 2, and 3, while questions 5 and 8 are reverse variables (3, 2, 1, 0). The total score ranges from 0 to 30, with a higher score indicating a higher level of depressive symptoms. A cutoff point of 10 shows high sensitivity and specificity for the diagnosis of depressive symptoms; thus, we used a cutoff point of 10 to dichotomize participants in our primary analysis.[22]

Assessment of T2DM

Study participants answered "yes" to the question, "have you been diagnosed with diabetes mellitus by a doctor?"

Model Construction

Based on Kessler's theory of psychological stress,[23] this study hypothesized that stressors directly or indirectly affect psychological stress responses through intermediary variables. Stressors included age, income status, diabetes duration, sleep duration, insulin use, frequency of blood glucose monitoring, exercise glycemic control awareness, and pain distress. The mediating variables were self-rated health and glycemic control, and depression symptoms represented stress outcomes.

Data Analysis

Statistical Package for Social Science (SPSS), software version 26.0, was used to analyze the data. For correlation analysis, Pearson's correlation was used for continuous variables, Spearman correlation for other types of variables, and Mplus 8.0 for model command construction and path analysis. The overall fitting model was acceptable with the following values: the ratio of likelihood ratio χ^2 values to degrees of freedom (CMIN/DF) less than twice, Tacker-Lewis fit index (TLI), comparative fit index (CFI) of all values greater than or equal to 0.900, and root mean square error of approximation (RMSEA) values less than or equal to 0.080. Statistical significance was set at $p < 0.05$. Finally, only the significant paths were included in the model. The specific assignments are presented in Table 1.

Results

Prevalence Status and Correlation Analysis results of Depression in Middle-Aged and Elderly Patients with Diabetes

Of the total 1743 patients with diabetes in this study, 740 were diagnosed with depression, accounting for 42.5%, with a self-rating depression scale score of 16.97±6.92 points. The Pearson's correlation results showed that age, sleep duration, pain distress score, and self-rated health score correlated with the depression score. The Spearman correlation results showed that gender, marital status, education level, income, glycemic control, blood sugar monitoring frequency, and blood sugar control awareness rate correlated with the depression score, whereas diabetes duration and insulin use were not associated with depression scores (see Tables 2 and 3).

Table 1 Variable Assignment

Gender	1= men;2=women
Age	Continuous variable
Education	1=illiterate; 2=elementary school; 3=junior high school; 4=high school/secondary school; 5=college or above
Marital status	1=married; 2=separated; 3=divorced; 4=widowed; 5=never married
Income	0=no income; 1=≤1000yuan; 2=1000–5000yuan; 3=5000–10000yuan; 4=≥10000yuan
Diabetes duration	1=less than 1 year; 2=2–5 years; 3=more than or equal to 5 years
Sleep duration	Continuous variable
Insulin use	0=no;1=yes
Frequency of blood glucose monitoring	0=no monitoring; 1=less than once a month; 2=at least once a month
Exercise glycemic control awareness	0=0 kinds; 1=1 kind; 2=2 kinds; 3=3 kinds; 4=4 kinds; 5=5 kinds
Pain distress	Continuous variable
Glycemic control	1=good; 2=bad; 3=do not know
Self-rated health	Continuous variable
Depression score	Continuous variable

Notes: According to the Likert scoring method, in the variable selection questionnaire for pain distress, "Do you often suffer from pain? Is it not at all, a little, a little, a lot, or a lot?"; about self-assessment health status selection questionnaire Medium "How do you think your health is? Is it good, good, fair, bad, or very bad?" Scoring, followed by "4, 3, 2, 1, 0" points.

Table 2 Pearson Correlation Analysis of Independent Variables and Depression Score (Rs)

	Age	Sleep Duration	Pain Distress	Self-Rated Health	Depression Score
Age	1				
Sleep duration	−0.074**	1			
Pain distress	−0.068**	0.229**	1		
Self-rated health	−0.085**	0.158**	0.374**	1	
Depression score	0.059*	−0.266**	−0.383**	−0.411**	1

Note: *P< 0.05 **P< 0.01.

Table 3 Spearman Correlation Analysis Between Independent Variables and Depression Scores (Rs)

	Gender	Education	Marital Status	Income	Diabetes Duration
Gender	1				
Education	−0.350**	1			
Marital status	0.176**	−0.155**	1		
Income	−0.204**	0.324**	0.025	1	
Diabetes duration	−0.076**	−0.005	−0.006	−0.025	1
Insulin use	−0.023	0.094**	0.018	0.064**	−0.159**
Frequency of blood glucose monitoring	−0.025	0.181**	−0.016	0.138**	−0.171**
Exercise glycemic control awareness	−0.121**	0.202**	−0.101**	0.098**	−0.084**
Glycemic control	0.076**	−0.060*	0.02	−0.094**	−0.005
Depression	0.029**	−0.247**	0.130**	−0.207**	−0.005
	Insulin use	**Frequency of blood glucose monitoring**	**Exercise glycemic control awareness**	**Glycemic control**	**Depression**
Insulin use	1				
Frequency of blood glucose monitoring	−0.01	1			
Exercise glycemic control awareness	0.129**	0.262**	1		
Glycemic control	0.02	−0.101**	−0.121**	1	
Depression	0.038	−0.084**	−0.099**	0.203**	1

Note: *P< 0.05, **P< 0.01.

Pathway Results of Influencing Factors of Depression in Patients with DM

Although diabetes duration and insulin use were not associated with depression scores in this study, existing studies have shown that they were both important influencing factors of depression in patients with diabetes; therefore, this study included them in the pathway analysis model.

This model had a good fit, and the fitting index was CFI=0.981 (>0.9), TLI=0.937 (>0.9), SRMR=0.026 (<0.10), RMSEA=0.027 (<0.08), and 2/df=2.31 (<3). The model results showed only statistically significant pathways (Insert Figure 1). The standardized direct, indirect, and total effects of depression in patients with diabetes are shown in Table 4. The results of the path model showed that gender, education level, and marital status, as control variables, had a direct impact on depression in patients with diabetes, with effects of 0.068, −0.087, and 0.078, respectively. The remaining variables were research variables, of which self-rated health had the largest direct effect on depression, with an effect size of −0.271. Income, diabetes duration, sleep duration, pain distress, and glycemic control directly affected depression. Self-rated health and glycemic control as mediator variables, income, diabetes

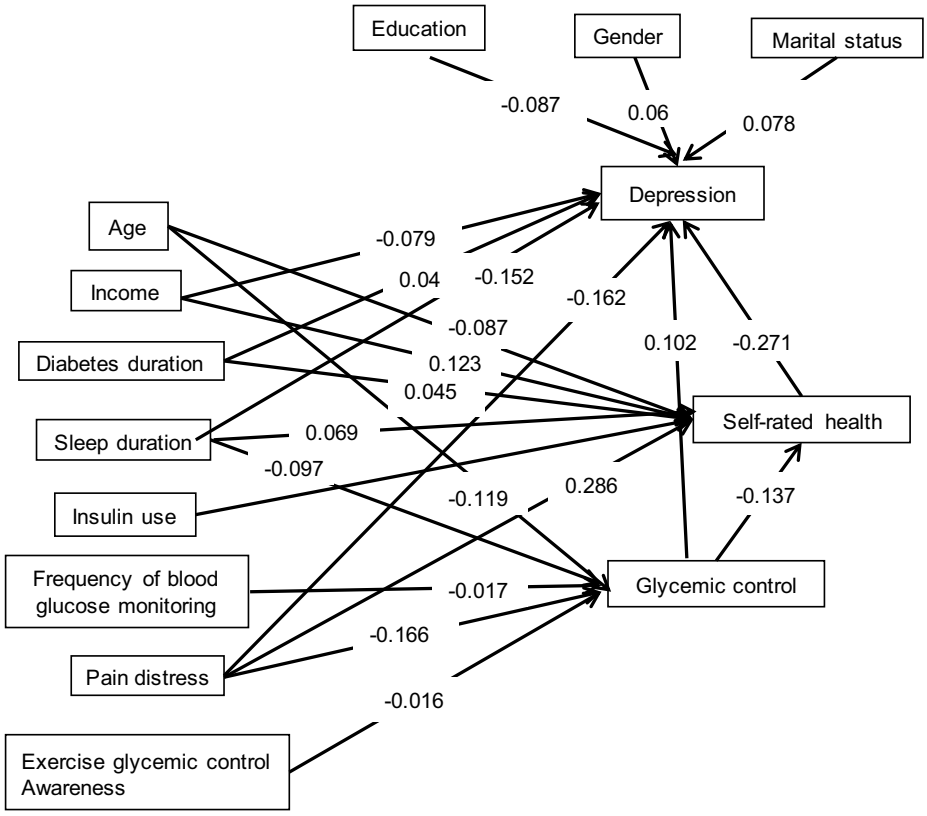

Figure 1 Pathway analysis model of depression in middle-aged and elderly patients with diabetes.

duration, sleep duration, pain distress, insulin use, and glycemic control could affect self-rated health and cause depression. Age, frequency of blood glucose monitoring, and exercise could lead to depression by affecting glycemic control, which could affect self-rated health by affecting glycemic control.

Table 4 Analysis Results of Depression Pathway in Middle-Aged and Elderly Patients with Diabetes

Independent Variable	Total Effect	Direct Effect	Indirect Effect
Gender	0.068	0.068	–
Education	−0.087	−87	–
Marital status	0.078	0.078	–
Age	0.007		0.007
Income	−0.112	−0.079	−0.033
Diabetes duration	0.032	0.044	−0.012
Sleep duration	−0.116	−0.152	0.036
Insulin use	0.032	–	0.032
Frequency of blood glucose monitoring	−0.017	–	−0.017
Exercise glycemic control awareness	−0.016	–	−0.016
Pain distress	−0.051	−0.162	0.101
Glycemic control	0.139	0.102	0.037
Self-rated health	−0.271	−0.271	–

Note: Total effect=direct effect + indirect effect.

Discussion

The detection rate of depression among middle-aged and elderly patients with diabetes in China was 42.5%, which was higher than that in Nepal (22.7%),[24] Ghana (31.3%),[19] and Spain (29.2%).[25] Gender and age may play a role; however, the populations included in the studies are comparable in terms of sex and age. Another reason may be the use of different self-rating depression scales. The number of questions answered differed between different scales; therefore, the aspects involved in the questions and the cutoff criteria for diagnosing depression varied, possibly leading to different levels of depression detection. The CES-D10 scale used in this study could effectively reduce the response fatigue of visitors. At the same time, the research population included in this study came from all provinces in China. This makes it more comprehensive, representative, and valuable than patients from hospitals or communities in a certain region. The detection level of depression in middle-aged and elderly patients with diabetes was relatively high and required more attention. Therefore, the relevant departments of the Chinese government propose incorporating depression screening into health checkups, focusing on patients diagnosed with depression, timely psychological intervention, and strengthening management. This may reduce the occurrence of depression.

Women living alone, with low education and low income, were more likely to develop depression. This may result from women's delicate emotions, poor ability to withstand pressure, and easy changes in hormone levels in the body, which affect mental health and increase the level of depression.[26,27] A meta-analysis[4] showed that the detection level of depression in patients aged > 60 years was higher than that in patients aged < 60 years. A possible reason for this is that, with age, patients' physical condition worsens, and self-health cognition changes. Poverty seriously affects the psychological state of patients, leading to an increase in the detection level of depression. Married patients could be taken care of and accompanied by their partners in terms of disease control and emotional support, which alleviates negative thoughts leading to anxiety and depression in patients. Patients with higher education[29] and higher income[28] are more likely to receive disease-related information to facilitate blood sugar control and disease management.

The results showed that patients with longer diabetes duration, insulin use, shorter sleep duration, and pain distress were more likely to develop depression. A possible reason is that the development of the disease could lead to complications, and the longer the disease course, the easier it is to experience anxiety, fear, and depression.[30] Insulin use leads to poorer self-efficacy and increased risk of depression.[31–33] Furthermore, sleep deprivation and poor sleep quality could lead to depression.[34] Pain distress can hinder patients' physical activity, seriously affect their normal work and life, and increase psychological distress.[35,36]

This study found that self-rated health and glycemic control, as mediating variables, had direct or indirect effects on the occurrence of depression, and self-rated health had a greater direct effect on depression. Self-rated health was the most commonly used indicator of a patient's own health cognition. Studies have shown that it could independently predict the occurrence of depression in patients with diabetes.[37] At the same time, the study also found that the worse the glycemic control, the more likely the development of depression.[19] Glycemic control was the fundamental measure to delay diabetes and its complications.[25] Strict diet control and drug treatment would inconvenience patients' lives, resulting in poor glycemic control. Self-rated health and glycemic control were used as mediating variables, and the remaining variables could lead to depression through the strengthening or weakening of the mediating variables. It might be that the patient's role in the disease becomes clearer as the disease progresses.[38,39] Good glycemic control, good disease awareness, high treatment cooperation, and self-health management knowledge would enable patients to adapt well to the disease state. This leads to an increased evaluation of self-health efficacy. However, after using insulin, patients might doubt their own health status, negatively affecting their psychological state and causing depression. Studies have shown that good sleep could promote positive health perception and health evaluations.[40] Additionally, pain distress could reduce patients' subjective health evaluations. Currently, patients control their blood sugar through regulated drug treatment, lifestyle changes, and blood sugar monitoring.[41] This study found that the frequency of blood glucose monitoring and the exercise glycemic control awareness rate could affect depression by affecting glycemic control.

Therefore, strengthening the health management of patients with diabetes plays an important role in effectively reducing the occurrence of depression. First, it is necessary to improve patients' evaluations of their own health status. Health literacy can be improved by including, for example, diet therapy, exercise therapy, weight control, smoking cessation, and

psychological guidance.[42] Additionally, it would help patients to correctly identify negative emotions, conduct regular psychological guidance, improve their self-regulation ability, and eliminate negative psychological effects.

Limitations

This study is a cross-sectional study. We were unable to determine whether there is a causal relationship between diabetes and depression variables; existing studies mostly used hemoglobin concentration as glycemic control. This study used questionnaires to describe self-reported blood sugar control, which may have affected the patient's true blood sugar control level. Additionally, with the serious increase in younger patients with diabetes, it is necessary to pay attention to their mental health. Follow-up research could include a wider age group through cohort research and explore its causal relationships.

Conclusion

Therefore, strengthening the health management of patients with diabetes plays an important role in effectively reducing the occurrence of depression. First, it is necessary to improve patients' evaluations of their own health status. Health literacy can be improved by including, for example, diet therapy, exercise therapy, weight control, smoking cessation, and psychological guidance.[42] Additionally, it would help patients to correctly identify negative emotions, conduct regular psychological guidance, improve their self-regulation ability, and eliminate negative psychological effects.

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Disclosure

The authors report no conflicts of interest in this work.

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