Patient Preference and Adherence

Dovepress

open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Mediation Effect of Self-Efficacy Between Health Beliefs and Glycated Haemoglobin Levels in Elderly Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study

Anqi Zhang[1,2,*], Jinsong Wang[1–3,*], Xiaojuan Wan[2], Jing Zhang[3], Zihe Guo[3], Yamin Miao[2], Shuhan Zhao[2], Shuo Bai[2], Ziyi Zhang[2], Weiwei Yang[4]

[1]The Affiliated Hospital of Yangzhou University, Yangzhou University, Yangzhou, Jiangsu, 225003, People's Republic of China; [2]School of Nursing and Public Health, Yangzhou University, Yangzhou, Jiangsu, 225009, People's Republic of China; [3]Yangzhou Commission of Health, Yangzhou, Jiangsu, 225009, People's Republic of China; [4]Community Health Service Center, Yangzhou, Jiangsu, 225003, People's Republic of China

*These authors contributed equally to this work

Correspondence: Jinsong Wang, The Affiliated Hospital of Yangzhou University, Yangzhou University, Yangzhou, Jiangsu, 225003, People's Republic of China, Tel +86 15952771632, Email wangjs@yzu.edu.cn

Purpose: To explore the mediating effect of self-efficacy in the relationship between glycated haemoglobin (HbA1c) levels and health beliefs in community elderly patients with type 2 diabetes.

Patients and Methods: From January to March 2022, convenience sampling was adopted to investigate 200 elderly patients with type 2 diabetes in a community in Yangzhou, China. Data were collected using the Health Beliefs Questionnaire, Self-efficacy for Diabetes, and Medication Compliance Questionnaire. Laboratory parameters included HbA1c, fasting blood glucose, postprandial blood glucose, total cholesterol, triglyceride, high-density-lipoprotein cholesterol, and low-density-lipoprotein cholesterol levels. Correlation, linear regression, and mediation analyses were performed using SPSS 27.0.

Results: HbA1c levels were higher in men (women vs men: 6.80% [6.08%, 7.73%] vs.7.30% [6.30%, 9.18%]) and employed (employed vs not employed vs retired: 7.60% [6.90%, 10.45%] vs 5.85% [5.40%, 6.95%] vs 7.10% [6.20%, 8.20%]) and low self-efficacy (low vs high: 13.1% [6.55%, 13.85%] vs 6.8% [6.10%, 7.70%]). HbA1c levels were negatively associated with health beliefs ($r = -0.246$) and self-efficacy ($r = -0.240$; $p<0.01$). Linear regression showed that perceived susceptibility, severity, benefit, and barriers, cues to action, and self-efficacy explained 50% of the variance in HbA1c levels after adjusting for sex and current work status. The mediation effect of self-efficacy was partial between health beliefs and HbA1c levels and accounted for 24.65% of the total effect ($p < 0.001$).

Conclusion: Health beliefs influenced the improvement of self-efficacy in older patients with type 2 diabetes mellitus, which in turn could improve HbA1c control. Self-efficacy plays a partial mediating role between health beliefs and Hba1c levels in elderly patients with type 2 diabetes.

Keywords: health belief model, self-efficacy, glycated haemoglobin, mediation analysis, elderly, type 2 diabetes mellitus

Introduction

The International Diabetes Federation 2021 reported that the number of people with diabetes mellitus (DM) has reached 140 million China and is expected to reach 170 million China by 2045.[1] In 2022, a Chinese epidemiological statistics show that elderly individuals (aged ≥65 years) accounted for 12.6% of the total Chinese population,[2] and approximately 30% of them had diabetes mellitus, with type 2 diabetes mellitus accounting for more than 9–5% of cases.[3,4] Glycated haemoglobin (HbA1c) levels are a key predictor of diabetes-related complications and mortality,[5] and their management in patients with type 2 diabetes can reduce the risk of related diseases.[6] Each 1% reduction in the HbA1c level is

Received: 6 September 2022
Accepted: 29 October 2022
Published: 5 November 2022

associated with a 14% reduction in the probability of myocardial infarction, 21% reduction in the incidence of diabetes-related complications,[7] and 6–15% reduction in mortality.[8,9] A study by the Joslin Diabetes Center in the United States showed that approximately 6.6% of older patients with diabetes had HbA1c control and that 20% of patients with diabetes for over 50 years were free of diabetic complications.[10] However, several studies have indicated that poor control of HbA1c levels in elderly patients with type 2 diabetes in some communities.[11–13] Therefore, in order to develop effective intervention measures for patients with type 2 diabetes, it is very important to understand the factors that affect the level of glycosylated hemoglobin.

The Health Belief Model (HBM) is commonly used in patients with diabetes to provide views on patients' health beliefs, behaviors, and health and disease information.[14] The theory assumes that people's health behaviours may be influenced by five dimensions of health beliefs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action.[15,16] HBM is widely used to explain and predict health behavior changes, such as vaccination,[17] disease screening[18] and treatment compliance of diabetic patients,[19] and to guide interventions to improve patients' self-care behavior, such as blood glucose self-test,[20] and physical exercise.[21] However, it is rarely used to explain the blood glucose management of elderly patients with type 2 diabetes in Chinese community. This study aimed to examine the effect of health belief levels on glycaemia in older patients with type 2 diabetes and to investigate whether or not self-efficacy has a mediation effect using HbA1c levels as a proxy.

Participants and Methods

Study Design

In this cross-sectional study (see STROBE Statement), we adopted the convenient sampling method to recruited elderly patients with type 2 diabetes from communities of the Wenfeng District, Yangzhou City between January and March 2022.

Sample and Sampling Technique

The inclusion criteria were as follows: (1) type 2 diabetes; (2) age >65 years; (3) clear consciousness, no intellectual problems; and (4) Volunteer to participate in this research, and be able to complete the questionnaire independently or under the guidance of researchers. The exclusion criteria were as follows: (1) severe endocrine diseases; (2) severe physical diseases; and (3) cognitive impairment; (4) severe visual, auditory or language impairment; and (5) with severe mental illness.

The sample size was calculated based on the expected prevalence of type 2 diabetes of 12% among the elderly with a Chinese study.[22] Therefore, the sample size was determined using the following formula:[23]

$$N = \frac{u_{\alpha}^2 p(1-p)}{\delta^2}$$

u_{α}=1.96, δ=0.05, p =12%, The sample size obtained by substituting the calculation formula was 162 cases. Taking into account factors such as sample loss or non-cooperation, the sample size was expanded by 20%. Therefore, the final consideration of this study was 195 samples.

Instruments

Sociodemographic Characteristics

Sociodemographic characteristics included age, sex, residential status, educational level, marital status, occupation, health insurance status, current work status, monthly household income, alcohol consumption status, smoking status, body mass index, duration of diabetes, treatment modalities, complications, and comorbidities.

Laboratory Indicators

HbA1c, fasting blood glucose, postprandial blood glucose, total cholesterol, triglycerides, high-density-lipoprotein cholesterol, and low-density-lipoprotein cholesterol levels were measured.

Self-Efficacy for Diabetes (SED) Scale

We used the Chinese version of the SED scale prepared by Lorig et al[24] and translated and revised by Wei et al.[25] The SED scale is used to measure the self-efficacy of patients with diabetes in terms of glycaemic control, exercise, medical condition monitoring, and diet. It contains a total of nine items, scored on a 5-point Likert scale, with higher scores indicating better self-efficacy. In this study, an SED score of ≤22.5 was categorised as low self-efficacy, while an SED score of >22.5 was categorised as high self-efficacy. Cronbach's alpha for this study was 0.853, demonstrating favourable internal consistency.

Health Beliefs Questionnaire

We adopted the Health Beliefs Questionnaire suitable for patients with diabetes designed by Yamei Chen based on the framework of the HBM proposed by Rosenstock et al,[26] with a Cronbach's alpha of 0.80 and five dimensions: perceived benefits (seven entries), perceived severity (three entries), perceived susceptibility (five entries), perceived barriers (two entries), and cues to action (three entries). The 5-point Likert scale was used, with higher scores indicating better health beliefs. The content validity of the Chinese version of the scale is 0.795 and Cronbach's alpha is 0.717,[27] demonstrating favourable internal consistency.

Data Collection Procedures

Eligible patients were invited to participate in the study and informed of the purpose and process of the study. After obtaining the patient's written consent, the researchers distributed paper questionnaires to patients in community hospitals and conducted laboratory tests. The questionnaire can be filled out by patients independently, or the researchers can read the questions aloud to help them complete the scale. When patients do not understand the medical terms used in the questionnaire, the researchers will give a brief description. The questionnaire is examined and collected by the researchers on the spot, and if there are any errors or omissions, assist patients to correct or fill in.

Statistical Analyses

Statistical analyses were performed using SPSS 27.0 (version 27.0 Chicago, IL, USA). Descriptive statistics were used to describe the distribution of demographics, glycaemic control, HBM, and SED. Continuous variables are expressed as means±standard deviations. Non-normally distributed variables are expressed as medians (quartiles). Non-parametric tests were used for intergroup comparisons. The correlation among glycaemic control, health beliefs, and self-efficacy in patients with diabetes was analysed using the Spearman correlation coefficient. Multiple linear regression was used to analyse factors affecting HbA1c levels, with HbA1c levels used as the dependent variable, health beliefs (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action), and self-efficacy used as independent variables, and sex and current work status used as control variables. The PROCESS macro developed by Hayes (Montoya & Hayes;[28] Preacher & Hayes)[29] was used to analyse the mediation model based on the HBM. Figure 1 shows the theoretical framework. The contingent effects of the independent variable X (health beliefs) may directly or indirectly influence the dependent variable Y (HbA1c via mediator M [self-efficacy]). "a" represented the effect of X on M, and "b" represented the effect of M on Y (Figure 1A). The specific and indirect effects of X on Y through M were estimated as "a" and "b". The total effect z was the sum of the mediation effects of the direct effects, which can be obtained using the following formula: c = c' + ab. Model 4 of Hayes' PROCESS macro was used, and the differences were considered to be statistically significant if the 95% bootstrap confidence interval (CI) did not cross 0. Furthermore, patient demographic characteristics were included in the model as control variables. A p-value <0.05 was set as statistical significance.

Results

Demographic Characteristics and Clinical Features

We enrolled a total of 200 patients with type 2 diabetes, with a mean age of 73.0 (69.0, 77.0) years, an HbA1c level of 7.00 (6.13, 8.20) %, a fasting glucose level of 7.69 (6.49, 9.10) mmol/L, and a 2-h postprandial glucose level of 11.29 (9.60, 13.75) mmol/L. Among the study participants, 51% were women, 86.5% were married, and 91.5% were resigned

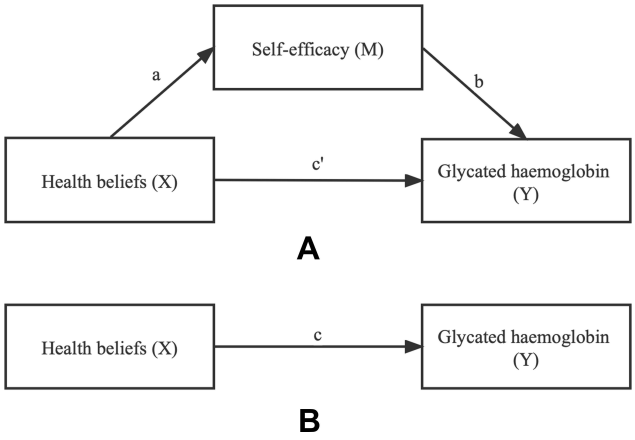

Figure 1 Model pathway: mediating role of self-efficacy between health beliefs and HbA1c levels in older patients with type 2 diabetes mellitus. (**A**) Direct and indirect effects of health beliefs on HbA1c levels. (**B**) Total effect of health beliefs on HbA1c levels.

or retired. Moreover, both smokers and alcohol consumers accounted for 11.5% of the participants. The mean duration of diabetes was 12.0 (6.0, 19.0) years, with 76% of the patients on oral hypoglycaemic drugs for glycaemic control, 23.5% with complications, and 76.5% with other comorbidities. The intergroup differences in HbA1c levels were significant ($p<0.05$) by sex, current work status, and self-efficacy (Table 1).

Health Beliefs and Self-Efficacy Among Patients with Type 2 Diabetes

In this group, 33 (16.5%) had low self-efficacy. In the HBM model, the average score of patients in the dimension of action cues was the highest.(Tables 1 and 2).

Correlation of HbA1c Levels with Health Beliefs and Self-Efficacy

HbA1c levels were negatively associated with the total health belief score (r=−0.246, $p<0.01$), and total self-efficacy score (r=−0.240, $p<0.01$; Table 3). HbA1c levels were negatively associated with four dimensions, ie perceived benefit (r=−0.205, $p<0.01$), perceived susceptibility (r=−0.259, $p<0.01$), perceived severity (r=−0.194, $p<0.01$), and cues to action (r=−0.328, $p<0.01$). There was a positive correlation between self-efficacy and the total score of health belief (r = 0.435, $p<0.01$).

Factors Affecting HbA1c Control

Table 4 shows the value assignment. The results from multiple logistic regression analysis showed that after adjusting for covariates, including sex (β=−0.696, $p=0.01$) and current work status (β=1.658, $p=0.051$), perceived benefit (β=−1.445, $p=0.022$), perceived susceptibility (β=−0.518, $p=0.032$), perceived severity (β=−0.541, $p=0.004$), perceived barriers (β=-0.591, $p=0.002$), cues to action (β=−1.058, $p=0.01$), and self-efficacy (β=−0.148, $p<0.001$) showed negative effects on HbA1c levels. The model explained 50% of the variance in HbA1c levels (Table 5).

Relationship Between HbA1c Levels and Health Beliefs: A Moderated Mediation Model

Health beliefs exerted a negative predictive effect on HbA1c levels (β=−0.24, t=11.6, $p<0.001$). When mediating variables were included, the direct negative predictive effect of health beliefs on HbA1c levels persisted (β=−0.18, t=3.82, $p<0.001$). Health beliefs were a significant predictor of self-efficacy (β=0.62, t=10.95, $p<0.001$), and self-efficacy was a significant negative predictor of HbA1c levels (β=−0.15, t=−3.82, $p<0.001$) (Figure 2, Table 6). Indicating a partial mediating effect of the self-efficacy between health beliefs and HbA1c levels, with a mediating effect (a × b) of −0.06, a direct effect (c') of −0.18, a total effect of −0.24, and an effect ratio of 24.65%. Thus, 24.65% of the effect of health beliefs on HbA1c levels was mediated by self-efficacy (Table 7).

Table 1 Demographic Characteristics and Clinical Features of the Study Population (n=200)

Characteristics and Classification	n (%)	Glycated Haemoglobin (%)	
		Median (Quartiles)	*t/p*
Sex			−2.225/0.026
Female	102 (51.0)	6.80 (6.08, 7.73)	
Male	98 (49.0)	7.30 (6.30, 9.18)	
Residential status			0.445/0.801
Living alone	15 (7.5)	7.10 (6.30, 9.50)	
Living as a couple	62 (31.0)	7.00 (6.10, 8.20)	
Living with family	123 (61.5)	7.10 (6.25, 7.88)	
Educational level			0.810/0.847
Illiterate or semi-literate	30 (15.0)	6.85 (5.98, 8.63)	
Primary school	52 (26.0)	6.90 (5.78, 8.70)	
Junior high school	65 (32.5)	7.00 (6.10, 8.20)	
High school and above	53 (26.5)	7.20 (6.40, 7.70)	
Marital status			−0.073/0.942
Married	173 (86.5)	7.00 (6.10, 8.20)	
Divorced/widowed	27 (13.5)	7.00 (6.30, 9.30)	
Medical insurance			1.929/0.381
Employees' health insurance	160 (80.0)	7.20 (6.20, 8.43)	
Residential health insurance	34 (17.0)	6.75 (6.05, 7.80)	
Commercial health insurance	6 (3.0)	6.45 (5.85, 7.43)	
Work status			6.390/0.041
Employed	12 (6.0)	7.60 (6.90, 10.45)	
Unemployed	5 (2.5)	5.85 (5.40, 6.95)	
Resigned or retired	183 (91.5)	7.10 (6.20, 8.20)	
Monthly household income (RMB)			1.360/0.715
<3000	36 (18.0)	7.00 (5.70, 7.70)	
3000–5000	59 (29.5)	7.20 (6.10, 10.50)	
5000–10,000	91 (45.5)	6.90 (6.20, 8.40)	
>10,000	14 (7.0)	7.40 (6.30, 7.60)	
Smoking status			−1.275/0.209
No	177 (88.5)	7.00 (6.10, 8.15)	
Yes	23 (11.5)	6.50 (6.50, 10.50)	
Alcohol consumption			−0.146/0.884
No	177 (88.5)	7.00 (6.20, 8.20)	
Yes	23 (11.5)	6.90 (5.70, 13.0)	
Treatment modality			3.086/0.379
None	10 (5.0)	6.85 (5.30, 7.68)	
Oral medication	152 (76.0)	6.90 (6.10, 8.18)	
Insulin	12 (6.0)	7.60 (6.15, 12.65)	
Oral medication + insulin	26 (13.0)	7.40 (6.30, 8.55)	
Comorbidities			0.886/0.375
No	160 (80.0)	7.00 (6.30, 7.80)	
Yes	40 (20.0)	6.80 (6.05, 7.70)	
Complications			0.827/0.408
No	47 (23.5)	6.80 (6.1, 7.7)	
Yes	153 (76.5)	7.25 (6.3, 8.08)	
Body mass index			−1.039/0.299
<24 kg/m^2	77 (38.5)	6.70 (5.70, 7.65)	
≥24 kg/m^2	123 (61.5)	6.90 (6.20, 7.70)	

(*Continued*)

Table 1 (Continued).

Characteristics and Classification	n (%)	Glycated Haemoglobin (%)	
		Median (Quartiles)	*t/p*
Course of disease			4.012/0.135
<5 years	48 (24.0)	6.95 (6.23, 7.70)	
5~10 years	40 (20.0)	6.60 (5.70, 7.70)	
>10 years	112 (56.0)	7.30 (6.30, 8.70)	
Self-efficacy			−4.664/0.001
Low	33 (16.5)	13.1 (6.55, 13.85)	
High	167 (83.5)	6.80 (6.10, 7.70)	

Table 2 Total Scores of Self-Efficacy and Health Beliefs and Scores for Each Dimension (n=200)

Item	Score	Mean Score of Item
Total health belief score	70.67±6.49	3.53±0.32
Perceived benefits	26.72±1.79	3.82±0.26
Perceived susceptibility	17.36±3.30	3.47±0.66
Perceived barriers	5.69±1.60	2.84±0.80
Cues to action	11.66±1.10	3.88±0.37
Perceived severity	9.23±2.60	3.07±0.87
Total self-efficacy score	25.82±4.26	2.87±0.47

Table 3 Correlation of HbA1c Levels with Health Beliefs, and Self-Efficacy (n=200)

	1	2	3	4	5	6	7	8	9	10
1. Glycated haemoglobin	1									
2. Age	−0.093	1								
3. Course of disease	0.106	0.194**	1							
4. Perceived benefits	−0.205**	0.038	0.059	1						
5. Perceived susceptibility	−0.259**	0.012	0.002	0.338**	1					
6. Perceived barriers	−0.194**	0.089	0.039	0.138	0.097	1				
7. Cues to action	−0.328**	0.028	−0.105	0.341**	0.318**	0.106	1			
8. Perceived severity	−0.100	0.073	−0.119	0.212**	0.255**	−0.364**	0.218**	1		
9. Health beliefs	−0.246**	0.089	0.010	0.610**	0.775**	0.219**	0.514**	0.497**	1	
10. Self-efficacy	−0.240**	−0.091	0.021	0.429**	0.439**	−0.01	0.373**	0.266**	0.435**	1

Notes: Spearman correlation analysis was performed to analyse the correlation of patients' HbA1c levels with the five dimensions of health beliefs and self-efficacy. **p<0.01.

Table 4 Value Assignment of Independent and Control Variables in the Multiple Linear Regression Model

Variable	Value Assignment
Sex	Women=0, men=1
Current work status	Unemployed=00; employed=10; resigned or retired=01
Perceived benefits	Continuous variables
Perceived susceptibility	Continuous variables
Perceived barriers	Continuous variables
Cues to action	Continuous variables
Perceived severity	Continuous variables
Self-efficacy	Continuous variables

Table 5 Multiple Linear Regression Model of Factors Influencing HbA1c Levels (n=200)

Model			Unstandardised Coefficient		Standardised Coefficient	t	Significance	Variance Inflation Factor
			β	Standard Error	β			
(Constant)			26.633	2.170		12.272	0	
Independent variables	Perceived benefits		−0.207	0.089	−0.147	−2.313	0.022	1.528
	Perceived susceptibility		−0.108	0.048	−0.141	−2.248	0.026	1.489
	Perceived barriers		−0.314	0.093	−0.199	−3.394	0.001	1.309
	Cues to action		−0.362	0.135	−0.157	−2.687	0.008	1.295
	Perceived severity		−0189	0.062	−0.195	−3.062	0.003	1.533
	Self-efficacy		−0.156	0.040	−0.264	−3.957	0.000	1.686
Control variables	Sex	Male	0.678	0.267	0.135	2.545	0.012	1.062
		Female	0					
	Current work status	Unemployed	1.526	0.839	0.103	1.818	0.071	1.027
		Employed	−0.950	0.572	−0.081	−1.662	0.098	1.103
		Resigned or retired	0					
R^2			0.499					
F			21.056					
p			<0.001					

Discussion

Health beliefs refer to the health behaviours and perceptions of health and diseases of the patient.[16] In other words, individual behaviour is determined by beliefs about diseases and behaviour, which is a main factor motivating individuals to adopt self-management measures[30] and may be closely related to the management of blood glucose levels. In this study, we investigated the relationship between health beliefs and HbA1c levels in older patients with type 2 diabetes with the mechanism of action. HbA1c levels showed significant negative correlations with perceived susceptibility, perceived severity, perceived benefit, perceived barriers, cues to action, and self-efficacy in older patients with type 2 diabetes. Self-efficacy showed a significant positive association with health beliefs and a significant mediation effect between health beliefs and HbA1c levels.

In this study, the median HbA1c level among 200 older patients with type 2 diabetes which was slightly higher than the HbA1c level of 7.0% for older individuals required by the 2021 Standards of Medical Care for Diabetes.[31] This may be due to the older age, greater prevalence of complications, and longer course of the disease in the study participants. The study found that glycosylated hemoglobin was poorly controlled in men, possibly because men had a lower perception of disease risk than women. This is consistent with previous studies in which female patients are more proactive than male patients in self-management and collect information about diabetes.[32] In addition, retirees have lower

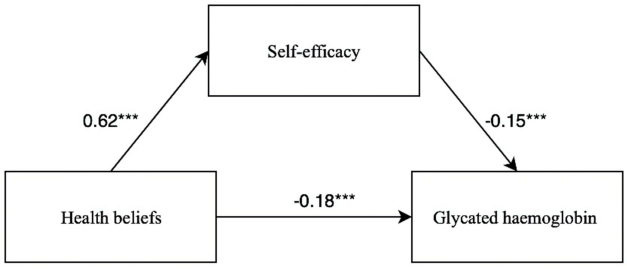

Figure 2 Parallel multi-mediation model of the relationship between health beliefs and HbA1c levels ***p<0.001.

Table 6 Mediation Test of Self-Efficacy Between Health Beliefs and HbA1c Levels (n=200)

Outcome Variable	Predictor Variable	*R*	R^2	*F (df)*	β	*t*
Glycated haemoglobin		0.69	0.47	58.96**(3)		
	Sex				−0.77	−2.92***
	Self-efficacy				−0.15	−3.82***
	Health beliefs				−0.47	−7.18***
Self-efficacy		0.62	0.38	60.49**(2)		
	Sex				0.001	0.02
	Health beliefs				0.62	10.95***
Glycated haemoglobin		0.66	0.44	75.93**(2)		
	Sex				−0.15	−2.83***
	Health beliefs				−0.63	−11.69***

Note: **p<0.01, ***p<0.001.

Table 7 Direct and Indirect Effects of Health Beliefs on HbA1c Levels

	Effect Size	Bootstrap Standard Error	Lower Limit of Bootstrap CI	Upper Limit of Bootstrap CI	Relative Effect Size
Mediation effect	−0.06	−0.02	−0.10	−0.02	24.65%
Direct effect	−0.18	0.03	−0.23	−0.13	73.35%
Total effect	−0.24	0.03	−0.29	−0.19	

Abbreviation: CI, confidence interval.

HbA1c levels than others, which may be because they have more free time and energy to self-manage diabetes and communicate with doctors.[33]

The level of health beliefs of the study participants was low, which was lower than the findings of Noppamas et al.[34] This may be due to the older age, long course of disease, lack of knowledge about the disease, and presence of other chronic comorbidities of the participants that affected their health beliefs to varying degrees. The study showed that health beliefs were significantly negatively associated with HbA1c levels and could be used as a negative predictor of HbA1c control, health beliefs may contribute to poor glycaemic control in patients through differences in perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action.[35] Positive health beliefs help to improve the management of patients' blood sugar and have a significant impact on health behavior,[36] consistent with the findings of randomised controlled trials.[37,38] Further analysis showed that except for perceived severity, the other four dimensions were negatively correlated with glycosylated hemoglobin level. Previous studies have shown that higher perceived severity is associated with better blood glucose management in diabetes.[39] However, other studies have shown that perceived severity does not affect changes in health behavior.[40] Meta analysis shows that there is a positive correlation between perceived severity and self-care. When patients' health condition is impaired, patients' self-care will change.[41] It may be that health beliefs in this study are mainly concerned with internal or external factors that encourage the implementation of healthy behavior, as well as patients' perception of the risk of complications.

Therefore, similar to previous studies, there is no consistent conclusion on perceived severity. Therefore, improving health beliefs of older patients with type 2 diabetes would improve patients' self-management capacities and help them improve their own blood glucose management.

This study found that self-efficacy was related to the level of glycosylated hemoglobin in patients. There is evidence that self-efficacy was also another important factor for improving individual health behaviours.[42] Smury et al[43] found that the higher the sense of self-efficacy, the stronger the self-care ability and the better blood glucose control. Similarly, studies have shown that self-efficacy is directly linked to lower glycosylated hemoglobin levels in patients.[44] The patients with higher self-efficacy have better behavior motivation, which determines the persistence and firmness of diabetes self-management, and makes them confident to deal with any factors in the environment that are not conducive to blood glucose control.[45] In addition, Bandura elaborated on the

links between mastery experience (mastery experiences), social model (social modeling) and social persuasion (Social persuasion) to improve self-efficacy.[46] Therefore, Strengthening health education and social support for elderly patients with type 2 diabetes may improve their self-efficacy and promote self-management, which in turn may improve glycaemic control.

Previous studies have used self-efficacy as an independent predictor of health beliefs. This study proposed and examined the mediation role of self-efficacy between health beliefs and HbA1c levels in older patients with type 2 diabetes. Our results suggested that health beliefs of older patients with type 2 diabetes indirectly influence HbA1c levels by affecting patients' self-efficacy. Among them, 24.65% of the effect of health beliefs on HbA1c levels was mediated through self-efficacy. Studies[47] have shown that health beliefs affect self-efficacy, and self-efficacy is a predictor of blood glucose control in patients with diabetes, which can predict patients' blood glucose management ability.[48] Psychological factors can affect the individual's ability of self-management, and then affect the individual's health.[49] Patients with higher health beliefs have higher self-efficacy and are more confident that they can control their blood sugar in the face of complex self-care of diabetes.[50] On the contrary, patients with lower health beliefs believe that they are unable to cope with the disease and that they will not have complications or serious consequences, which will reduce their sense of self-efficacy and affect their self-care behavior,[51] resulting in poor blood sugar control. Therefore, improving health beliefs and knowledge about the disease and boosting confidence regarding overcoming the disease and managing the conditions in older patients with type 2 diabetes are beneficial for maintaining good blood glucose levels. As self-efficacy acts as a mediation variable between health beliefs and HbA1c levels, it can be improved with health interventions. Furthermore, the role of health beliefs in improving patients' glycaemic control may be better exploited through improved self-efficacy of patients. In summary, both health beliefs and self-efficacy of patients should be improved for the glycaemic management of patients with diabetes.

Strengths

First of all, we use glycosylated hemoglobin as an objective index to evaluate the level of blood glucose control in patients with diabetes, ensuring the consistency of measurements, and the results are comparable. Secondly, we control the covariates to reduce the influence of confounding variables to avoid factors that may limit the generalization of the results.

Limitations

This study has some limitations. First, the study population was mainly urban, and the results may differ from those obtained in rural areas. Second, a structured questionnaire was adopted to investigate the self-efficacy, and health beliefs of patients with diabetes through self-assessment, and recall bias may have affected the results. Finally, due to the cross-sectional design, this study only provided information of the participants at one time point. The causal relationship should be tested through a longitudinal study in the future.

Conclusions

Assessing patients' glycaemic control is part of the comprehensive management of patients with diabetes, and the provision of timely support is important to enhance glycaemic control. In this study, factors influencing glycaemic control in older patients with type 2 diabetes were determined, and the relationship among these factors was elucidated. Moreover, this study provided novel ideas for intervention studies on glycaemic control and a theoretical basis for the development of intervention programs for glycaemic control in older patients with type 2 diabetes.

It is suggested that in the future, health care providers should strengthen the evaluation of health beliefs and self-efficacy of this population, and improve patients' health beliefs and self-efficacy by providing corresponding health education and support and then more effectively improve patients' self-management ability and quality of life, improve blood glucose control.

Patient and Public Involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Data Sharing Statement

All data relevant to the study are included in the article or uploaded as Supplementary Information.

Ethics Approval and Consent to Participate

The study protocol was approved by the Research Ethics Committee of the School of Nursing, Yangzhou University (YZUHL20210091). All participants were informed of their study rights, including the study purpose, confidentiality, privacy protection, and the right to withdraw at any time, and signed an informed consent form before data collection with questionnaires. This study strictly adhered to the ethical standards of the Declaration of Helsinki.

Acknowledgments

Thanks to the School of Nursing of Yangzhou University, the Affiliated Hospital of Yangzhou University, and the Community Health Service Center of Wenfeng Street, Guangling District, Yangzhou City.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

Cadre Health Care Research Project of Jiangsu (BJ17011).

Disclosure

The authors report no conflicts of interest in this work.

References

1. Sun H, Saeedi P, Karuranga S, et al. IDF diabetes atlas: global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res Clin Pract*. 2022;183:109119. doi:10.1016/j.diabres.2021.109119
2. National Bureau of Statistics. Statistical bulletin of the People's Republic of China on national economic and social development in 2019[EB/OL]; 2020. Available from: http://www.stats.gov.cn/tjsj/zxfb/202002/t20200228_1728913.html. Accessed November 2, 2022.
3. National Bureau of Statistics. Seventh national population census bulletin (No. 5); 2021. Available from: http://www.stats.gov.cn/tjsj/tjgb/rkpcgb/qgrkpcgb/202106/t20210628_1818824.html. Accessed November 2, 2022.
4. Li Y, Teng D, Shi X, et al. Prevalence of diabetes recorded in mainland China using 2018 diagnostic criteria from the American Diabetes Association: national cross sectional study. *BMJ*. 2020;369:m997. doi:10.1136/bmj.m997
5. Liu Y, Ye W, Chen Q. Resistance exercise intensity is correlated with attenuation of HbA1c and insulin in patients with type 2 diabetes: a systematic review and meta-analysis. *Int J Environ Res Public Health*. 2019;16(1):140.
6. Luo M, Lim WY, Tan CS. Longitudinal trends in HbA1c and associations with comorbidity and all-cause mortality in Asian patients with type 2 diabetes: a cohort study. *Diabetes Res Clin Pract*. 2017;133:69–77. doi:10.1016/j.diabres.2017.08.013
7. Kim KJ, Choi J, Bae JH, et al. Time to reach target glycosylated hemoglobin is associated with long-term durable glycemic control and risk of diabetic complications in patients with newly diagnosed type 2 diabetes mellitus: a 6-year observational study. *Diabetes Metab J*. 2021;45(3):368–378. doi:10.4093/dmj.2020.0046
8. Critchley JA, Carey IM, Harris T, et al. Glycemic control and risk of infections among people with type 1 or type 2 diabetes in a large primary care cohort study. *Diabetes Care*. 2018;41(10):2127–2135. doi:10.2337/dc18-0287
9. Rodriguez-Gutierrez R, Gonzalez-Gonzalez JG, Zuñiga-Hernandez JA, et al. Benefits and harms of intensive glycemic control in patients with type 2 diabetes. *BMJ*. 2019;367:l5887. doi:10.1136/bmj.l5887
10. Tinsley LJ, Kupelian V, D'Eon SA, et al. Association of glycemic control with reduced risk for large-vessel disease after more than 50 years of type 1 diabetes. *J Clin Endocrinol Metab*. 2017;102(10):3704–3711. doi:10.1210/jc.2017-00589
11. Elbarbary M, Honda T, Morgan G, et al. Ambient air pollution exposure association with diabetes prevalence and glycosylated hemoglobin (HbA1c) levels in China. Cross-sectional analysis from the WHO study of AGEing and adult health wave 1. *J Environ Sci Health*. 2020;55(10):1149–1162. doi:10.1080/10934529.2020.1787011
12. Yu Y, Xie K, Lou Q, et al. The achievement of comprehensive control targets among type 2 diabetes mellitus patients of different ages. *Aging*. 2020;12(14):14066–14079. doi:10.18632/aging.103358
13. Zhu HT, Yu M, Hu H, et al. Factors associated with glycemic control in community-dwelling elderly individuals with type 2 diabetes mellitus in Zhejiang, China: a cross-sectional study. *BMC Endocr Disord*. 2019;19(1):57. doi:10.1186/s12902-019-0384-1

14. Yılmaz M, Aktaş B, Dereli F, et al. Health beliefs, self-care behaviors and quality of life in adults with type 2 diabetes. *Florence Nightingale J Nurs*. 2020;28(2):221–229. doi:10.5152/FNJN.2020.19102
15. Jalilian F, Motlagh FZ, Solhi M, et al. Effectiveness of self-management promotion educational program among diabetic patients based on health belief model. *J Educ Health Promot*. 2014;3:14. doi:10.4103/2277-9531.127580
16. Dehghani-Tafti A, Mazloomy Mahmoodabad SS, Morowatisharifabad MA, et al. Determinants of self-care in diabetic patients based on health belief model. *Glob J Health Sci*. 2015;7(5):33–42. doi:10.5539/gjhs.v7n5p33
17. Zambri F, Perilli I, Quattrini A, et al. Health belief model efficacy in explaining and predicting intention or uptake pertussis vaccination during pregnancy. *Ann Ist Super Sanita*. 2021;57(2):167–173. doi:10.4415/ANN_21_02_09
18. Asril NM, Tabuchi K, Tsunematsu M, et al. Predicting healthy lifestyle behaviours among patients with type 2 diabetes in Rural Bali, Indonesia. *Clin Med Insights Endocrinol Diabetes*. 2020;13:1179551420915856. doi:10.1177/1179551420915856
19. Letta S, Aga F, Assebe Yadeta T, et al. Self-care practices and correlates among patients with type 2 diabetes in Eastern Ethiopia: a hospital-based cross-sectional study. *SAGE Open Med*. 2022;10:20503121221107337. doi:10.1177/20503121221107337
20. Hashim SA, Mohd Yusof BN, Abu Saad H, et al. Effectiveness of simplified diabetes nutrition education on glycemic control and other diabetes-related outcomes in patients with type 2 diabetes mellitus. *Clin Nutr ESPEN*. 2021;45:141–149. doi:10.1016/j.clnesp.2021.07.024
21. Xue-Liu L, Mu X. The positive effect of perceived exercise benefit and the negative effect of perceived severity of disease and weakness on college students' amount of exercise: the mediate and suppressor role of physical fitness evaluation self-efficacy. *Front Psychol*. 2021;12:762865. doi:10.3389/fpsyg.2021.762865
22. Shi W, Wang Q, Zhang J, et al. Incidence tendency analysis on type 2 diabetes in 4 asian countries - China, Malaysia, Singapore, and Thailand, 1990–2019. *China CDC Wkly*. 2021;3(52):1113–1117. doi:10.46234/ccdcw2021.268
23. Wild CJ. Chance encounters: a first course in data analysis and inference. 2000.
24. University LSJ. Stanford patient education research center self-efficacy for diabetes[EB/OL]; 2009. Available from: http://patienteducation.stanford.edu/. Accessed November 2, 2022.
25. Wei J. *A study on the correlation between knowledge, self-efficacy and self-management behavior of elderly diabetic patients in rural areas* [master]. Hangzhou Normal University; 2013.
26. Chen Y. *A survey of compliance and its influencing factors in readmitted diabetic patients* [master]. Central South University; 2007.
27. Qian MA, Kunjuan JI, Yuying L. Study on constructing structure equation model about the effect of health beliefs on self-management behaviors in diabetic patients. *Chin Nurs Res*. 2019;33(24):4294–4298.
28. Montoya AK, Hayes AF. Two-condition within-participant statistical mediation analysis: a path-analytic framework. *Psychol Methods*. 2017;22(1):6–27. doi:10.1037/met0000086
29. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav Res Methods*. 2008;40(3):879–891. doi:10.3758/BRM.40.3.879
30. Strecher VJ, Rosenstock IM. The health belief model. *Cambridge Handbook Psychol Health Med*. 1997;113:117.
31. American Diabetes Association. Older adults: standards of medical care in diabetes-2021. *Diabetes Care*. 2021;44(Suppl 1):S168–s179. doi:10.2337/dc21-S012
32. Tsutsui H, Nomura K, Kusunoki M, et al. Gender differences in the perception of difficulty of self-management in patients with diabetes mellitus: a mixed-methods approach. *Diabetol Int*. 2016;7(3):289–298. doi:10.1007/s13340-015-0249-4
33. Nguyen VB, Thi KHP, Nguyen TX, et al. Diabetes self-management and its associated factors among patients with diabetes in central Vietnam: a cross-sectional study. *PLoS One*. 2022;17(7):e0270901. doi:10.1371/journal.pone.0270901
34. Pipatpiboon N, Koonrungsesomboon N, Suriyawong W, et al. Perception of benefits and barriers associated with dementia prevention behaviors among people with diabetes. *Nurs Health Sci*. 2022;24(1):274–282. doi:10.1111/nhs.12922
35. Chen M, Yun Q, Lin H, et al. Factors related to diabetes self-management among patients with type 2 diabetes: a Chinese cross-sectional survey based on self-determination theory and social support theory. *Patient Prefer Adherence*. 2022;16:925–936. doi:10.2147/PPA.S335363
36. Swaleh RM, Yu C. "A touch of sugar": a qualitative study of the impact of health beliefs on type 1 and type 2 diabetes self-management among black Canadian adults. *Can J Diabetes*. 2021;45(7):607–613.e602. doi:10.1016/j.jcjd.2020.12.002
37. Ağralı H, Akyar İ. The effect of health literacy-based, health belief-constructed education on glycated hemoglobin (HbA1c) in people with type 2 diabetes: a randomized controlled study. *Prim Care Diabetes*. 2022;16(1):173–178. doi:10.1016/j.pcd.2021.12.010
38. Alyami M, Serlachius A, Mokhtar I, Broadbent E. Illness perceptions, HbA1c, and adherence in type 2 diabetes in Saudi Arabia. *Patient Prefer Adherence*. 2019;13:1839–1850. doi:10.2147/PPA.S228670
39. Şermet Kaya Ş, Kitiş Y. Elderly diabetes patients' health beliefs about care and treatment for diabetes. *J Human Sci*. 2018;15(1):51. doi:10.14687/jhs.v15i1.4903
40. Huang CH, Lin PC, Chang Yeh M, et al. A study on self-care behaviors and related factors in diabetes patients. *Hu Li Za Zhi*. 2017;64(1):61–69. doi:10.6224/JN.64.1.61
41. Tavakoly Sany SB, Ferns GA, Jafari A. The effectiveness of an educational intervention based on theories and models on diabetes outcomes: a systematic review. *Curr Diabetes Rev*. 2020;16(8):859–868. doi:10.2174/1573399816666191223110314
42. Seyde E, Taal E, Wiegman O. Risk-appraisal, outcome and self-efficacy expectancies: cognitive factors in preventive behaviour related to cancer. *Psychol Health*. 1990;4(2):99–109. doi:10.1080/08870449008408144
43. Kong S-Y, Cho M-K. Factors related to self-care in patients with type 2 diabetes. *Open Nurs J*. 2020;14(1):64–73. doi:10.2174/1874434602014010064
44. Lee AA, Piette JD, Heisler M, Janevic MR, Rosland AM. Diabetes self-management and glycemic control: the role of autonomy support from informal health supporters. *Health Psychol*. 2019;38(2):122–132. doi:10.1037/hea0000710
45. Yang L, Li K, Liang Y, Zhao Q, Cui D, Zhu X. The mediating role of self-efficacy in the relationship between social support and self-management in patients with type 2 diabetes. *Nurs Pract Res*. 2017;14(24):119–121.
46. Bandura A. *On the Functional Properties of Perceived Self-Efficacy Revisited*. Vol. 38. Los Angeles, CA: Sage Publications Sage CA; 2012:9–44.
47. Lo SST, Kok WM. Osteoporosis knowledge, health beliefs, and self-efficacy in Hong Kong Chinese men. *Arch Osteoporos*. 2022;17(1):60. doi:10.1007/s11657-022-01104-x

48. Hurst CP, Rakkapao N, Hay K. Impact of diabetes self-management, diabetes management self-efficacy and diabetes knowledge on glycemic control in people with Type 2 Diabetes (T2D): a multi-center study in Thailand. *PLoS One*. 2020;15(12):e0244692. doi:10.1371/journal.pone.0244692
49. Kulzer B, Albus C, Herpertz S, et al. Psychosocial factors and diabetes. *Exp Clin Endocrinol Diabetes*. 2021;129(S 01):S91–s105. doi:10.1055/a-1284-6524
50. Khalilipour M, Panahi R. Effect of education on promoting preventive behaviors of premenstrual syndrome in female adolescents: health belief model application. *J Educ Commun Health*. 2017;4(2):44–54. doi:10.21859/jech.4.2.44
51. Glanz K, Rimer BK, Viswanath K. *Health Behavior: Theory, Research, and Practice*. John Wiley & Sons; 2015.