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ORIGINAL RESEARCH

Mediating Effects of Health Literacy Between Self-Efficacy and Quality of Life in Patients with Type 2 Diabetes Mellitus

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Objective: The purpose of this study is to investigate how health literacy mediates the link between type 2 diabetes mellitus patients' self-efficacy and quality of life.

Methods: Between January 2025 and April 2025, researchers gathered a convenience sample of T2DM patients from six hospitals in Shaanxi Province, China. These participants completed the Diabetes-Management SE Scale, Health Literacy Scale for Chronic Patients, and the Short Form 36 Health Survey Questionnaire to assess their self-efficacy, health literacy, and quality of life. We used SPSS 27.0 and Mplus 8.3 software to perform statistical analysis of the relationships between variables.

Results: Patients with T2DM had a moderate quality of life score of 59.48 ± 14.57. Self-efficacy and quality of life were positively correlated ($r = 0.950$, $p < 0.001$). Furthermore, the association between self-efficacy and quality of life was partially mediated by health literacy ($\beta = 0.276$, 95% CI = 0.201–0.346, $p < 0.001$), with the mediating impact explaining 36.0% of the overall effect.

Conclusion: In patients with T2DM, self-efficacy and quality of life are substantially correlated, and health literacy mediates this relationship. The above findings provide scientific evidence for developing intervention strategies.

Keywords: diabetes, self-efficacy, health literacy, quality of life, cross-sectional study

Introduction

Diabetes has become a major public health concern worldwide. Approximately 537 million adults globally, or 10.5% of the population aged 20–79, have diabetes, primarily type 2 diabetes mellitus, according to surveys. Type 2 diabetes mellitus (T2DM) refers to abnormal glucose metabolism and related metabolic disorders caused by insufficient insulin secretion or cellular resistance to insulin, and is one of the most common forms of diabetes.[1,2] China reportedly has the world's highest number of persons with T2DM at the moment, and the number is continuing to grow.[3] About 824,000 Chinese adults lost their lives to diabetes and its complications in 2019. Medical costs associated with diabetes came in second, after the US.[4] Due to the rising incidence of T2DM, the persistently high rates of morbidity and mortality caused by diabetes and its complications, and the associated significant economic burden, T2DM has become one of the most serious chronic diseases threatening human health.[5]

Quality of life is considered the main result of patient-centered healthcare, which is also being utilized more and more as a comprehensive health indicator in medical interventions and health surveys.[6] A person's assessment of their living circumstances, aspirations, expectations, standards, and worries in relation to their culture and value systems is what the World Health Organization (WHO) refers to as their quality of life. Previous studies have shown that as the disease progresses, patients with T2DM are prone to complications such as neurological disorders, cardiovascular disease, diabetic foot, anxiety, and depression, which severely affect their social and psychological well-being and daily

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functioning.[7] According to reports, persons with T2DM frequently have a reduced quality of life, especially when it comes to their physical and psychological functioning.[8] Impaired quality of life, however, frequently results in a reduction in patients' capacity for self-care, which impacts their motivation to continue treatment. This, in turn, causes blood glucose control to deteriorate, the risk of complications to rise, and the short- and long-term deterioration of diabetes to worsen. It is evident that enhancing the quality of life for diabetics has emerged as a pressing concern that requires attention.

Self-efficacy, as an important concept in social cognitive theory, is related to a person's conviction and assurance in their capacity to successfully complete tasks and effectively execute skills. It also represents the cognitive evaluation of one's own behavioral capabilities.[9] A high level of self-efficacy is crucial for implementing self-care behaviors. Currently, self-efficacy has been widely applied in diabetes research. Previous studies have shown that compared with patients with low self-efficacy, T2DM patients with high self-efficacy have a healthier attitude towards life and are better able to overcome difficulties or stress. In addition, some scholars believe that patients with higher self-efficacy have stronger self-management abilities and fewer disease-related physiological and psychological symptoms.[10] Higher self-efficacy patients were more likely to seek scientifically supported adaptive coping strategies and had better quality of life, according to a randomized controlled study.[11] In conclusion, research has shown that self-efficacy and quality of life are significantly correlated, although it is yet unknown the pathway of action.

The cognitive and social abilities that influence a person's motivation and capacity to obtain, comprehend, and apply knowledge to support and preserve good health are referred to as health literacy. According to research, chronic disease patients with higher self-efficacy have better health literacy. They tend to actively seek mental health information and professional help, adopt healthier lifestyles, improve skills for coping with illness, and develop beneficial health management behaviors to better promote recovery from illness.[12] Among persons with T2DM, those possessing health literacy are better equipped to acquire disease management knowledge and skills, thereby actively engaging in self-management. For instance, they can regularly monitor blood glucose levels and take medications on schedule. Such proactive self-management behaviors can effectively control disease progression, reduce the risk of complications, and positively link to their quality of life. Poor health literacy is linked to worse blood glucose control when compared to good health literacy, with a ratio range of 2.03–4.76.[13] Furthermore, a growing body of research has demonstrated that health literacy and quality of life in individuals with T2DM are positively correlated. Having adequate health literacy is an essential precondition for guaranteeing an optimal degree of quality.[14,15] However, the effect of health literacy on quality of life and whether it mediates the relationship between self-efficacy and quality of life among Chinese patients with T2DM have yet to be investigated, prompting healthcare providers whether they can think about integrating interventions like health literacy into their everyday quality of life management practices.

Social cognitive theory (SCT) was proposed by American psychologist Albert Bandura.[16] Initially developed as a theoretical framework to explain learning processes, it has since been widely applied in the field of health behavior research. This theory emphasizes that individuals' cognition of health knowledge (risks and benefits) is a prerequisite for behavioral change. According to the core viewpoint of SCT, people tend to perform behaviors that are expected to produce positive outcomes, and the core factor in this process is individual self-efficacy. As a crucial psychological construct in the field of health psychology, extensive research confirms that self-efficacy is significantly associated with adaptive coping mechanisms during stress responses. It can exert positive effects on health outcomes by influencing health behaviors. Based on the SCT theoretical framework, we found that self-efficacy not only improves health literacy by promoting motivation to explore information and boosting confidence in problem-solving, but also enhances patients' ability to critically evaluate and use health resources in complex environments by promoting proactive learning. Notably, individuals with good health literacy tend to actively seek and acquire health knowledge and better understand health information, which is more conducive to making healthy decisions, such as rationalizing their diets and exercising regularly, leading to improved health status, which is strongly associated with good health outcomes (quality of life). It should be noted that, in addition to self-efficacy, research indicates that sociodemographic factors (such as age, educational level, and economic pressure) and disease-related factors (such as course of disease and comorbidities) are typically significantly associated with the quality of life of T2DM patients. Educational level is also closely linked to individual health literacy. However, the core value of self-efficacy lies in its ability to help individuals break through

structural limitations. Specifically, even if educational level affects the basic level of health literacy, self-efficacy can still regulate the activation efficiency of individuals' existing knowledge and skills, producing a compensatory effect. In summary, this study is based on Bandura's Social Cognitive Theory and focuses on individual controllable psycho-behavioral pathways (self-efficacy→health literacy→quality of life) rather than the mechanism of action of structural factors. To control for potential confounding effects, the study has controlled for sociodemographic factors as covariates. This theoretical focus not only conforms to the current research trends in health psychology but also facilitates the discovery of universal intervention targets.

In conclusion, despite the fact that prior research has connected self-efficacy, health literacy, and quality of life, there are still a lot of unanswered questions in the literature, and the exact mechanism by which self-efficacy influences T2DM patients' quality of life has not been well investigated. Aside from these observations, not much research has examined how health literacy influences the connection between self-efficacy and quality of life in persons with T2DM. This study intends to close this gap by clarifying the intricate relationship among quality of life, health literacy, and self-efficacy. In addition to addressing a significant research vacuum, studies that examine health literacy as a mediating factor also open up avenues for focused interventions.

We put out the following hypotheses in light of the theoretical framework and literature review:

1. Self-efficacy is positively correlated with health literacy in patients with T2DM.
2. Health literacy mediates the relationship between self-efficacy and quality of life in patients with T2DM.
3. Health literacy is positively associated with the quality of life of individuals in patients with T2DM.

Methods

Study Design

A cross-sectional study approach was used in this investigation. Furthermore, this study adhered to the "Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist" guidelines. Researchers conducted the study from January 2025 to April 2025 using convenience sampling to select study participants from the endocrinology departments of six tertiary hospitals in Shaanxi Province. The inclusion criteria are as follows: (1) Fulfills one of the American Diabetes Association's diagnostic standards for DM: ① a fasting plasma glucose level of 126 mg/dl or above, or a self-reported diagnosis of diabetes by a medical practitioner; ② The 2-hour PG during the OGTT ≥ 200 mg/dL (11.1 mmol/L); ③ The HbA1c level is 6.5% or higher; (2) being at least eighteen years old; (3) The patient is conscious and has complete mobility and cognitive abilities; (4) Obtain the patient′s informed consent and sign the informed consent form. The following are the exclusion criteria: (1) There are serious mental disorders, the patient is completely unable to communicate, understand, and think; (2) Acute/end-stage diabetic complications, such as diabetic ketoacidosis (DKA), severe hypoglycemic coma, or end-stage diabetic nephropathy, and so on; (3) Combined with other systemic serious diseases (Diseases that may be life-threatening, negatively impact daily functioning and quality of life, or place excessive stress on caregivers). Including but not limited to: ① Circulatory system diseases, such as cardiogenic shock; NYHA Class III–IV heart failure, etc; ② Respiratory diseases, such as acute respiratory distress syndrome (ARDS); COPD at GOLD stages 3–4 (FEV1%<50%); or requiring long-term home oxygen therapy; ③ Neurological disorders, severe traumatic brain injury (GCS≤12 points), or any condition causing significant functional impairment (modified Rankin Scale score>4 points); ④ Tumors, such as active malignant tumors (non-locally curable tumors), with an expected survival period of < 6 months, etc.; ⑤ Infectious diseases, such as sepsis with organ failure, etc.; ⑥ Digestive system diseases, such as decompensated cirrhosis/acute severe pancreatitis; ⑦ Endocrine system diseases, such as thyroid crisis; (4) Pregnancy or other unique forms of diabetes. The formula $Z^2_{1-\alpha/2}P(1-P) / \delta^2$ was used to get the necessary sample size. The prevalence of diabetes in China is roughly 12.4%, according to studies.[17] As a result, $P = 0.124$, $\alpha=0.05$, $Z_{1-\alpha/2} = 1.96$, $\delta = 0.05$ is set for this investigation. The sample size was determined to be 167 using the formula. The minimal sample size was calculated to be 200, taking into account a 20% non-response rate. A valid response rate of 90.25% was obtained from the distribution of 400 questionnaires, of which 361 were returned. Based on the results of the 361 study participants in this study, post-hoc power analysis was conducted using G*Power software version 3.1.9.4 to assess the statistical power of the study. The results indicated that the statistical power of this study was 99% at the 95% confidence interval level with a moderate effect size.

Ethics

The Air Force Medical University's First Affiliated Hospital Ethics Committee gave its approval to this study (Approval No: KY20242029-C-1). All participants signed informed permission papers and willingly consented to participate in the study before to the questionnaire survey. The Declaration of Helsinki's tenets are adhered to in the research implementation process.

Measurement

General Information

Researchers developed a general information questionnaire through literature review and consultation with endocrinology experts. The questionnaire primarily includes sociodemographic characteristics and disease-related characteristics, such as age, sex, ethnicity, place of residence, Course of disease, treatment methods, HbA1C, number of complications, and comorbidities.

Diabetes Management SE Scale

In 1999, Bijl et al[18] created the DMSES to measure diabetic patients' self-efficacy. It was then modified into a cross-cultural Chinese form by Shu et al.[19] The 20 items of the Chinese version of the DMSES are broken down into four subscales: food, exercise, blood glucose monitoring, and medication. A Likert scale with 11 points, from 0 to 10, is used to rate each project. The DMSES Chinese version has a total score that varies from 0 to 200 points. The degree of diabetic self-efficacy increases with a higher score. The validity and reliability of the DMSES are adequate. Cronbach's α coefficient in this study was 0.940.

Health Literacy Scale for Chronic Patients

American researchers Jordan et al[20] created this scale, and Zhang[21] translated it into Chinese. Each of the 24 items on the scale has a score between 1 and 5. The four components of this scale are the ability to access information, communication and interaction skills, desire to seek financial support, and willingness to improve health. Higher scores indicate higher levels of health literacy; the total score goes from 24 to 120 points. Basic health literacy is defined as a total score of 96 or higher. The scale's Cronbach's alpha in this study was 0.930, suggesting that it has strong validity and reliability.

The Short Form 36 Health Survey Questionnaire

The Boston Health Institute created the SF-36 to gauge a person's quality of life in relation to their health.[22] Eight subjective health aspects are formed by the 36 items in the questionnaire, which can be summed up into two scales: mental and physical. The physical quality of life scale is made up of physical functioning, role constraints brought on by physical ailments, physical pain, and overall health. Vitality, emotional role limits, social functioning, and mental health are among the dimensions that make up the psychological quality of life scale. Higher scores indicate a higher quality of life. The scale's total score goes from 0 to 100. The validity and reliability of the questionnaire are good.

Covariates

This study collected participants' sociodemographic characteristics and disease-related characteristics as covariates, including Age (years), Sex (male/female), Ethnicity (Han/others), Educational Level (Primary school and below/ Middle school or High school or Junior college/ Bachelor's degree or above), Economic pressure (Mild/Moderate/ Severe), Place of residence (City/ Rural), Course of disease (≤5/6-9/≥10), Treatment methods (No treatment/Drug treatment/ Drug and insulin therapy), HbA1C (6.5–7.0/>7.0), Family history (No/Yes), Number of complications (0/ 1-3/≥4), Comorbidities (No/Yes).

Data Collection

Prior to implementation, investigators prepared consent forms, explanatory materials, and questionnaire content. The explanatory materials emphasize the purpose of the questionnaire, guidelines for answering questions, and important precautions and explanations. Investigators underwent uniform training on questionnaire distribution, with a focus on questionnaire completion methods, informed consent principles, research objectives and significance, and questionnaire

instructions. The questionnaires were distributed by two investigators who had received standardized training, and a researcher was specifically assigned to supervise the caliber of the data collection procedure. Initially, the team members emailed and met in person with the directors of the endocrinology departments at six prestigious hospitals. The participants were given paper questionnaires or linked to electronic questionnaires by the researchers when they were granted authorization to administer the study. Participants were informed information on the study's relevance and goal, all possible dangers, and emergency contact details prior to filling out the questionnaire. After the study was completed, the data were properly stored and only researchers and authorized personnel had access to them.

Data Analysis

SPSS 27.0 and Mplus 8.3 software were used for all statistical analyses in this study, and a two-tailed $p < 0.05$ threshold was used for statistical significance. Means, standard deviations, frequencies, and proportions are the primary descriptive statistics used to assess the quality of life of persons with T2DM. To investigate and assess differences between the study variables, we employed *t*-tests or analysis of variance. The correlation between quality of life, health literacy, and self-efficacy was ascertained using Pearson's correlation analysis. Lastly, we tested the model's direct and indirect effects using the bias-corrected percentile technique. Using path analysis, determine the t-value, p-value, standard error (SE), and beta coefficient (β) for every path in the model. A significant indirect effect was defined as one in which the mediating path's 95% CI did not contain zero. We investigated the model of the relationship between quality of life, health literacy, and self-efficacy using the aforementioned analysis and testing. We employed the following criteria to evaluate the model fit: $\chi 2/df \leq 3.00$, RMSEA<0.08, IFI≥0.90, TFI≥0.90, and CFI≥0.90.

Results

Characteristics of the Study Participants

Patients with T2DM have a generally moderate quality of life, according to the study's patients' mean quality of life score of 59.48 with a standard deviation of 14.57. This study included general characteristic data from 361 patients with T2DM, including sociodemographic characteristics and disease-related characteristics. In addition, except for the patient's gender (P=0.515), Other sociodemographic and disease-related quality of life scores were statistically significant (P<0.05). Refer to Table 1 for specifics.

Correlation Analysis

Table 2 displays the association coefficients between quality of life, health literacy, and self-efficacy. There exists a positive correlation between self-efficacy, health literacy, and quality of life variables among T2DM patients, according to the findings of the bivariate correlation analysis of the research variables.

Table 1 Univariate Analysis of Quality of Life in Patients with T2DM

Variables	The Quantity of Cases (Percentage)	Scores of Quality of Life ($\bar{x} \pm s$)	t/F	p
Age			4.744	<0.001
18–45years old	48(13.3%)	73.46±4.81		
45–59years old	141(39.1%)	62.07±13.05		
≥60years old	172(47.6%)	53.45±14.29		
Sex			0.190	0.515
Male	215(59.6%)	59.89±14.57		
Female	146(40.4%)	58.87±14.60		
Ethnicity			8.500	<0.001
Han	354(98.1%)	59.10±14.46		
Others	7(1.9%)	78.29±3.40		

(*Continued*)

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Table 1 (Continued).

Variables	The Quantity of Cases (Percentage)	Scores of Quality of Life ($\bar{x} \pm s$)	t/F	p
Educational Level			3.309	<0.001
Primary school and below	132(36.6%)	52.05±12.79		
Middle school/High school/Junior college	177(49.9%)	62.55±14.41		
Bachelor's degree or above	52(14.4%)	67.87±10.68		
Economic pressure			1.489	0.029
Mild	46(12.7%)	61.41±14.30		
Moderate	157(43.5%)	58.91±14.52		
Severe	158(43.8%)	59.47±14.74		
Place of residence			0.127	0.019
City	169(46.8%)	57.57±14.11		
Rural	192(53.2%)	61.16±14.80		
Course of disease (years)			24.500	<0.001
≤5	155(42.9%)	70.39±7.62		
6–9	125(34.6%)	56.82±11.63		
≥10	81(22.4%)	42.69±10.35		
Treatment methods			7.938	<0.001
No treatment	15(4.2%)	58.07±5.43		
Drug treatment	245(67.9%)	63.03±15.18		
Drug and insulin therapy	101(28.0%)	51.07±9.78		
HbA1C			17.835	<0.001
6.5–7.0	67(18.6%)	45.66±16.37		
>7.0	294(81.4%)	62.63±12.12		
Family history			18.192	<0.001
No	98(27.1%)	64.26±11.61		
Yes	263(72.9%)	57.68±15.26		
Number of complications			17.734	<0.001
0	186(51.5%)	69.95±6.99		
1–3	119(33.0%)	48.12±13.38		
≥4	56(15.5%)	48.82±8.68		
Comorbidities			6.090	<0.001
No	89(24.7%)	66.43±12.36		
Yes	272(75.3%)	57.20±14.54		

Table 2 Correlation Analysis Between Variables

	Mean (SD)	1	2	3
1. Self-efficacy		1	0.953**	0.950**
2. Health literacy			1	0.938**
3.Quality of life				1

Note: **p < 0.01.
Abbreviation: SD, Standard Deviation.

Multiple Regression Analysis

Multiple linear regression analysis was conducted using the dependent variable, the quality of life of patients with T2DM, as well as independent variables, such as age, ethnicity, educational level, course of disease, treatment methods, HbA1C, family history, number of complications, and comorbidities, that were statistically significant in the univariate analysis. As shown in Table 3, among these important variables, age ≥ 60 years old, middle school/high school/junior college education level, longer disease duration, higher HbA1C level, a family history of diabetes, and have complications and comorbidities

Table 3 Multivariate Linear Regression Analysis of Quality of Life

Variables	B	SE	β	t	p
Self-efficacy	0.348	0.035	0.432	10.062	<0.001
Health literacy	0.362	0.033	0.433	11.031	<0.001
Age					
45–59years old	0.857	0.618	0.029	1.386	0.167
≥60years old	−1.431	0.671	−0.049	−2.133	0.034
Ethnicity					
Others	−1.983	1.248	−0.019	−1.589	0.113
Educational Level					
Middle school/High school/Junior college	−1.262	0.508	−0.043	−2.484	0.013
Bachelor's degree or above	−0.466	0.675	−0.011	−0.690	0.490
Economic pressure					
Moderate	−0.212	0.528	−0.007	−0.402	0.688
Severe	0.092	0.544	0.003	0.170	0.865
Place of residence					
Rural	−0.625	0.357	−0.021	−1.748	0.081
Course of disease					
6–9	−1.670	0.711	−0.050	−2.348	0.019
≥10	−7.202	1.643	−0.231	−4.383	<0.001
Treatment methods					
Drug treatment	1.621	0.591	0.056	2.743	0.006
Drug and insulin therapy	5.502	0.855	0.160	6.438	<0.001
HbA1C					
>7.0	−2.139	0.563	−0.057	−3.797	<0.001
Family history					
Yes	−1.515	0.551	−0.047	−2.747	0.006
Number of complications					
1–3	−2.803	0.846	−0.077	−3.313	0.001
≥4	0.072	1.807	0.002	0.040	0.968
Comorbidities					
Yes	−1.391	0.520	−0.041	−2.673	0.008

Note: B, Regression Coefficient.
Abbreviation: SE, Standard Error.

are at risk for having a poor quality of life. However, patients who are more health literate and self-efficacious typically have better quality of life. Additionally, compared with not taking any diabetes treatment measures, drug treatment or a combination of drug and insulin therapy is a protective factor for patients' quality of life.

Table 4 and Figure 1 provide a thorough analysis of our mediation model's pathways. The findings show that among persons with T2DM, self-efficacy, health literacy, and quality of life are significant relationships. First, a high beta coefficient ($\beta = 0.489$) and a significant p-value ($p < 0.001$) indicate that self-efficacy has an association with health

Table 4 Effect Analysis of the Mediation Model

Path	Estimate	SE	95%Confidence Interval	P
Self-efficacy → health literacy	0.489	0.005	0.419–0.566	0.003
Health literacy → quality of life	0.300	0.048	0.210–0.385	0.006
Direct effect (Self-efficacy → quality of life)	0.919	0.047	0.885–0.951	0.003
Indirect effect (Self-efficacy → health literacy → quality of life)	0.276	0.038	0.201–0.346	0.006
Total effect	0.765	0.015	0.736–0.793	0.004

Abbreviation: SE, Standard Error.

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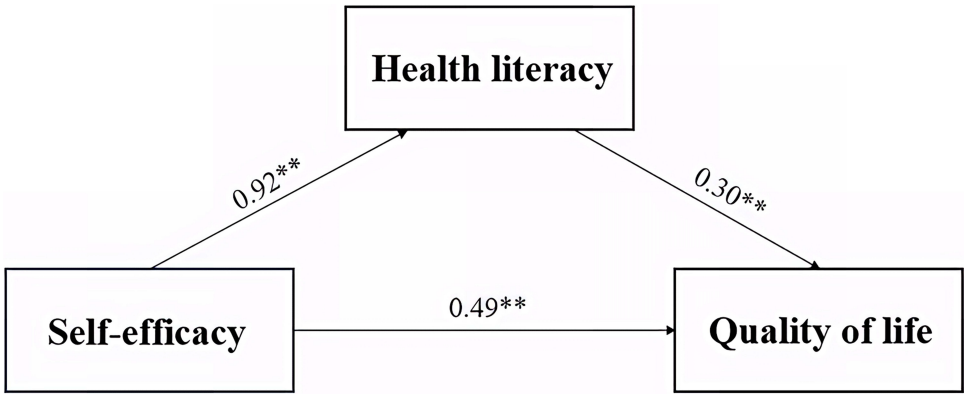

Figure 1 Mediating effect of health literacy on the relationship between self-efficacy and quality of life.
Note: The model was controlled for covariates. **p < 0.01.

literacy. The association is robust, as evidenced by the 95% CI for this impact, which falls between 0.419 and 0.566. This result supports hypothesis 1: Self-efficacy is positively correlated with health literacy in patients with T2DM.

With a p-value of 0.006, health literacy also significantly associates with the quality of life for persons with T2DM (β = 0.300). The effect's confidence interval, which varies from 0.210 to 0.385. This result supports hypothesis 3: Health literacy is positively associated with the quality of life of individuals in patients with T2DM.

The indirect effect of self-efficacy on quality of life through health literacy is also noteworthy. Additionally, to assess the robustness of the results, we compared the indirect effect estimates obtained under different Bootstrap sampling frequencies (1000 and 5000 iterations). Results indicate that when the number of samples increased from 1000 to 5000, the indirect effect of health literacy on the relationship between self-efficacy and quality of life remained stable (1000 samples: β = 0.276, 95% CI [0.201, 0.346];5000: β = 0.276, 95% CI [0.201, 0.346]), indicating that the estimation of this mediating effect is insensitive to different number of samples and further supporting the robustness of the research findings. This result supports hypothesis 2, which states that "Health literacy mediates the relationship between self-efficacy and quality of life in patients with T2DM. Finally, the total effect of self-efficacy on quality of life is significant (β = 0.765), with a confidence interval ranging from 0.736 to 0.793. Both the direct and indirect impacts of self-efficacy on life quality are included in this overall effect.

Discussion

This study, grounded in the social cognitive theory framework, examined the close relationship among self-efficacy, health literacy, and quality of life in patients with T2DM. Through a mediation model, it validated the mediating role of health literacy between self-efficacy and quality of life. This mechanism-based finding not only deepens our understanding of the intrinsic pathways among the aforementioned variables but also provides a theoretical anchor for developing targeted intervention strategies. Additionally, this study explored sociodemographic factors associated with quality of life, aiding clinicians in rapidly identifying high-risk T2DM patient groups with lower quality of life. This provides evidence-based support for implementing precision medical interventions and optimizing targeted healthcare services.

Patients with T2DM Have a Positive Correlation Between Their Self-Efficacy and Quality of Life

The findings of this study indicate that there is a positive correlation between self-efficacy and quality of life among patients with T2DM. This is in line with earlier research, like that conducted by Stromberg[23] and Egede,[24] which highlighted how high levels of self-efficacy can enhance the connection between diabetes patients' quality of life and symptoms. Studies on patients with coexisting diabetes and mental illness/non-alcoholic fatty liver disease have revealed that good self-efficacy also has a positive effect on improving the quality of life of patients with comorbidities.[25,26] Longitudinal study results on patients with hemorrhagic stroke also show that patients with high

self-efficacy experienced statistically significant improvements in quality of life as early as three months after discharge. The close link between the two emphasizes the role of self-efficacy as a cognitive-motivational catalyst in the acute rehabilitation phase of patients.[27] The above findings are consistent with Bandura's theory, which states that a strong sense of self-efficacy enhances psychological simulations of rehabilitation success, thereby accelerating goal-oriented rehabilitation behavior.

A Significant Mediating Factor in the Link Between Quality of Life and Self-Efficacy Is Health Literacy

After controlling for covariates, this study found that health literacy mediated the relationship between self-efficacy and quality of life in patients with T2DM (β=0.276, 95% CI 0.201–0.346, p=0.006). Bootstrap analysis further supports the robustness of this mediating effect, and the aforementioned findings are of significant importance. In patients with T2DM, the moderating role of health literacy indicates that there is a subtle relationship between positive psychological structure, health literacy, and living standards, which not only aligns with the psychosocial pathways of individual controllability proposed in Bandura's social cognitive theory, but also corresponds with findings from studies by Parichat[28] and Aihemaiti.[29] Previous studies have shown that self-efficacy is considered a core driver of health literacy.[30] Furthermore, the study indicates that health literacy helps to transform disease management confidence into executable health decisions, and plays an important "bridge" role between self-efficacy and quality of life of patients with T2DM through specific skill support, daily self-management, and other behavioral empowerment, or by enhancing the sense of control and reducing disease-related anxiety and other psychological buffers. However, it is worth noting that while Bootstrap analysis supports the robustness of the mediating effect, cross-sectional designs cannot entirely rule out the influence of unmeasured confounders. In future research, we will incorporate additional variables and conduct longitudinal or intervention studies to validate these findings.

Practical Significance

Focus on Self-Efficacy in T2DM Patients

This study confirms the significant position of self-efficacy in T2DM management. Results demonstrate a significant positive correlation between self-efficacy, health literacy, and quality of life, which to some extent elucidates the mechanism of "efficacy belief-competence construction-behavioral change" in Bandura's social cognitive theory. Although the cross-sectional design limits causal inference, enhancing self-efficacy may still be a significant breakthrough in the "knowledge-action gap" in diabetes management. Furthermore, the strong statistical association between self-efficacy and health literacy/quality of life observed in the mediation model underscores the clinical value of systematically enhancing patients' self-efficacy in diabetes education interventions. Therefore, in addition to traditional biomedical interventions, focusing on and enhancing patients' self-efficacy can serve as a valuable complementary strategy. In Diabetes Self-Management Education and Support (DSMES) programs, incorporating the cultivation of self-efficacy into intervention content holds potential value. In summary, researchers and clinicians should focus on the significance of self-efficacy in diabetes management, including people's capacity to follow medication and treatment plans, manage stress, and make healthy lifestyle choices.[31]

Increasing T2DM Patients' Health Literacy

The findings of this study confirm that health literacy serves as a crucial bridge linking positive psychological structures (self-efficacy) to health outcomes (quality of life). Good health literacy often promotes individuals' understanding of health information, improves the quality of doctor-patient interactions, and enhances self-management capabilities are associated with health outcomes. These findings suggest that the improvement of health literacy is a potential intervention target worthy of attention in the management of T2DM. Although cross-sectional study designs have limitations in determining temporal relationships between variables, the observed mediating effect pattern of health literacy in this study, combined with its theoretical positioning and intervention-friendly characteristics in the field of health promotion, provides a direction for future research. The findings support further exploration of the potential application value in diabetes management of structured training programs targeting health literacy. In summary, based on current research

findings and existing theoretical frameworks, we believe that paying attention to enhancing health literacy holds significant importance during the treatment and management of diabetes. Therefore, medical staff should focus on the variable of health literacy in clinical work. During interventions, they must move breakthrough mere knowledge dissemination and focus on cultivating patients' comprehensive competency chain of "understanding-application-decision-making." For example, first, healthcare professionals should be aware of the health literacy level of patients while treating them and use the proper assessment techniques to swiftly and accurately determine the health literacy level of T2DM to provide individualized health education and effective communication strategies. Second, healthcare professionals should enhance the ability of patients with T2DM to access information. Previous studies have shown that online navigation training interventions (knowledge transfer) have a positive effect on improving the health information search strategies and the ability to search for and find online information among patients with chronic diseases. Remind clinical staff that they can match the information provided with patients' health control points to enhance their capabilities by strengthening their skills in accessing, understanding, assessing, or applying health information. Third, healthcare professionals should actively communicate with patients to understand their needs regarding health information and actively provide them with health guidance. For example, we can gain insight into patients' needs for enhanced health information in a variety of ways, such as group studies, questionnaires, online information searches, and downloadable applications.[32,33] Fourth, the implementation of an informational and personalized intervention approach. As smartphone apps can provide information through visualization such as graphics, videos, and pictures, it is easier for patients to understand.[34] Suggests that we can use visual methods and interactive e-health interventions to increase patients' motivation for lifestyle and health literacy. During the intervention process, attention should be paid to the level of patients' smart device use and individualized programs should be adjusted according to age and other factors; timely improvements should be made based on the evaluation of the intervention by patients and their opinions on its future development. Finally, since health literacy is not only related to the level of education and communication skills of patients, but also to the communication skills and motivation of healthcare providers. Therefore, medical personnel should receive professional training and acquire the knowledge and skills required for health promotion and education; the Government can also encourage medical institutions and health service providers to carry out health promotion and education work by actively establishing incentives and evaluation mechanisms, and so on.

Identify High-Risk T2DM Patients with Lower Quality of Life and Actively Implement Intervention Measures

It is worth noting that the quality of life for individuals with T2DM directly reflects their level of mental well-being and physical health. First, healthcare providers should use tools such as the Short Form 36 Health Survey Questionnaire (SF-36) to assess the quality of life of patients with T2DM. Second, the study's findings demonstrated that a patient's quality of life is influenced by factors, including age, ethnicity, educational level, course of disease, treatment methods, HbA1C, family history, number of complications, and comorbidities. Therefore, caregivers should focus on the quality of life of older adults, Middle school/High school/Junior college, the longer the course of disease, the higher the HbA1C, patients with a family history of diabetes, complications or comorbidities. In summary, in clinical practice, nursing staff can identify high-risk individuals with T2DM who have lower quality of life based on assessment results and sociodemographic characteristics, thereby developing personalized care plans.

According to research, Cognitive Behavioral Therapy (CBT) uses cognitive-behavioral models to tap into the thought patterns triggered by an individual's behavioral and physiological responses to different stimuli and has a positive effect on addressing emotional issues in patients with T2DM. For example, group cognitive-behavioral therapy provided by GPs helped to reduce mild or moderate anxiety and depression, improve HbA1C concentrations, reduce diabetic distress, and increase their level of mental well-being, which in turn enhanced their quality of life.[35] Therefore, healthcare professionals can implement relevant measures by utilizing cognitive behavioral therapy (CBT) in conjunction with nursing techniques. Additionally, healthcare professionals can actively develop lifestyle intervention programs. Diet and exercise should be key components of lifestyle intervention, which is the cornerstone of managing and enhancing the quality of life for individuals with T2DM, according to the American Diabetes Association's guidelines.[36] The vicious cycle may be broken, β-cell function restored, and the progression of T2DM reversed by taking prompt and efficient steps (weight loss surgery, intensive insulin therapy, and lifestyle interventions) to reduce weight below the individual fat threshold before β-cell loss becomes irreversible.

Lifestyle therapies are non-invasive and have a wider range of applications than weight loss surgery and insulin therapy. Previous randomized controlled trials have demonstrated that lifestyle interventions characterized by personalized low-calorie dietary plans and moderate-intensity physical exercise are effective in controlling blood glucose, weight, and improving patients' quality of life.[37,38] Therefore, clinical nursing professionals may think about implementing lifestyle interventions like combining diet (low-energy diet, LCD, and Mediterranean diet) with physical activity (moderate-intensity aerobic and resistance exercises, walking, and maintaining habitual physical activity) to improve treatment outcomes for patients with T2DM and ultimately improve their quality of life.

Limitations

However, there are still some limitations. First, due to the cross-sectional design, all core variables were measured at the same point in time. Therefore, the results of the mediation analysis can only a statistical association patterns of association between variables and cannot yet infer causality or directionality. Specifically, although we hypothesized the path of self-efficacy → health literacy → quality of life in T2DM patients based on social cognitive theory and previous empirical research, reverse relationships may equally hold true. Therefore, the current findings should be regarded as exploratory analysis rather than causal evidence. Future research may further validate the findings of this study through the following approaches: (1) Employing a longitudinal design, self-efficacy, health literacy, and quality of life indicators were measured repeatedly at intervals of 3–6 months. Cross-lagged panel models (CLPM) or random intercept cross-lagged panel models (RI-CLPM) were utilized to examine temporal relationships among variables. (2) Design intervention trials, such as implementing a T2DM self-efficacy training program based on Bandura's social cognitive theory, and evaluate its effects on health literacy and quality of life through randomized controlled trials to provide causal evidence; (3) Explanatory sequence mixing method can be used to study the design, incorporating qualitative research methods such as in-depth interviews or focus groups based on quantitative analysis. It delves into the interactive mechanisms of these variables and their culturally specific manifestations from the perspective of patient agency.

Second, we found an exceptionally high correlation among self-efficacy, health literacy, and quality of life in this study. Within the context of Chinese culture, an individual's cognitive abilities, capacity for information acquisition, and social skills are often closely intertwined with their standard of living. Additionally, we found that some items in the health literacy scale overlap with self-efficacy-related content (eg, "I believe I can manage health issues"). The Social Functioning/Emotional Role dimension included in the SF-36 questionnaire also exhibits some conceptual overlap with items from the Health Literacy/Self-Efficacy scale. In summary, this indicates that some measurement overlap may exist in this study. Therefore, we will consider this as a key factor in statistical analysis and scale refinement in future research. Third, the core variables of this study (self-efficacy, health literacy, and quality of life) were all measured using self-report scales. Although this method offers advantages such as ease of operation and lower costs, it is subject to recall bias due to the subjective nature of self-reporting. Furthermore, a single self-assessment method may also lead to common method bias. To enhance research validity, future studies will incorporate objective indicators (such as clinical physiological parameters and medical record data) to conduct multidimensional evaluations of variables, thereby achieving complementary advantages between subjective and objective measurement approaches. Finally, the study's sample representativeness was limited as it only comprised tertiary-level Grade A hospitals in Shaanxi Province. Therefore, in order to further improve the generalizability of the study results, we will think about extending the study period, increasing the sample size, and broadening the geographical scope to include T2DM patients from a wider region in future research.

Conclusions

This study demonstrated the intricate connection between T2DM patients' self-efficacy, health literacy, and quality of life. This study demonstrated a favorable correlation between patients' self-efficacy and quality of life. In addition, health literacy plays an important mediating role in this relationship. These findings provide a theoretical basis for developing intervention strategies.

Data Sharing Statement

Data supporting the results of this study are available from the corresponding author upon request.

Ethical Statement

The study was conducted in accordance with the principles of the Declaration of Helsinki. It was approved by the Ethics Committee of the First Affiliated Hospital of Air Force Medical University (Approval No. KY20242029-C-1). All participants volunteered to participate in the study and signed an informed consent form.

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.

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Disclosure

The authors have no conflicts of interest to disclose for this work.

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