Postprint: Influence Pathways of Diabetes Knowledge and Self-Efficacy on Self-Management and Quality of Life in Rural Type 2 Diabetes Patients Based on the ITHBC Model

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Abstract

Background Due to a large elderly population and insufficient health services, the self-management level of patients with type 2 diabetes mellitus in rural China is relatively low, and their mortality risk is higher. Improving diabetes knowledge helps patients enhance self-efficacy, strengthen self-management, and improve quality of life. Therefore, diabetes knowledge and self-efficacy are crucial to patients' self-management and quality of life.

Objective To understand the influence pathways of diabetes knowledge and self-efficacy on self-management and quality of life in rural patients with type 2 diabetes mellitus.

Methods A cross-sectional design was employed. In August 2022, 2,193 rural patients with type 2 diabetes mellitus were selected from Binhai County, Jiangsu Province, using random cluster sampling. The included patients were surveyed using the Diabetes Knowledge Scale (ADKnowl), Chronic Disease Self-Efficacy Scale (SECD6), Diabetes Self-Management Behavior Scale (SDSCA), and Diabetes-Specific Quality of Life Scale (DSQL). A total of 2,010 valid questionnaires (91.66%) were ultimately collected. A model was constructed based on the Integrated Theory of Health Behavior Change (ITHBC), and multiple linear regression analysis was used to explore the influence pathways of ADKnowl and SECD6 scores on SDSCA and DSQL scores.

Results The ADKnowl, SECD6, SDSCA, and DSQL scores of rural patients with type 2 diabetes mellitus were (52.5$\pm$16.5), (6.4$\pm$1.2), (37.9$\pm$6.9), $and(48.3\pm8.6), respectively. Multiplelinearre$
$0.05), themediatingeffectofSECD6scorewas0.012(P < 0.05), andtheindirecteffectaccountedfor7.1 =$
$0.352)anddiet(= 0.161)dimensionscoresinADKnowlhadpositiveeffectsonSDSCAscore(P <$
$0.05), whiletheriskreductionofcomplications(= -0.213), exercise(=$

$-0.117), and diet(= -0.197) dimension scores had negative effects on DSQL score (P < 0.05). The symptom management self-efficacy(= -0.115) and disease generic management self-efficacy($=-0.397) dimension scores in SECD6 had negative effects on DSQL score (P<0.05).

Conclusion Diabetes knowledge can improve the level of self-management and quality of life in rural patients with type 2 diabetes, and self-efficacy and self-management have positive mediating effects. Moreover, acquisition of diabetes-related knowledge such as diet, exercise, and foot care can significantly improve patients' self-management and quality of life. It is recommended that multiple departments collaborate to conduct long-term health education in relevant areas and provide social support resources, enhance healthcare professionals' emphasis on diabetes patients' knowledge level and self-efficacy, and effectively improve the self-management behaviors and quality of life of rural diabetes patients.

Full Text

Pathway Analysis of the Impact of Diabetes Knowledge and Self-efficacy on Self-management and Quality of Life among Rural Patients with Type 2 Diabetes Mellitus Based on ITHBC Modeling

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Abstract

Background: China has the largest population of type 2 diabetes mellitus (T2DM) patients worldwide. Rural areas face particular challenges, including a high proportion of elderly residents, low education levels, weak disease prevention awareness, and uneven distribution of medical resources. These factors result in significantly lower self-management levels and quality of life among rural diabetes patients compared to their urban counterparts, along with higher mortality risk. Diabetes knowledge refers to information and understanding about diabetes, while self-efficacy encompasses confidence in one' s knowledge and skills, motivation, and ability to achieve behavioral goals in specific contexts. Accumulating diabetes knowledge helps patients accurately assess their capabilities and limitations, reduces feelings of isolation and anxiety, improves mental health, and enhances self-efficacy. This knowledge also enables proper use of glucometers and mobile applications for self-management, thereby improving quality of life, particularly among empty-nest middle-aged and elderly patients. Conversely, patients with high self-efficacy demonstrate greater confidence in

daily self-monitoring and medication adjustment, leading to increased emphasis on self-management, greater participation in self-management and social activities, and improved health-related quality of life. Self-efficacy may mediate the pathway from diabetes knowledge to self-management, while both self-efficacy and self-management may mediate the pathway from diabetes knowledge to quality of life. However, these pathways have received insufficient attention in the literature.

Objective: To elucidate the pathways through which diabetes knowledge and self-efficacy influence self-management and quality of life among rural T2DM patients.

Methods: We conducted a cross-sectional study in August 2022 using randomized whole-cluster sampling to survey 2,193 rural T2DM patients in Binhai County, Jiangsu Province. Participants completed the Diabetes Patient Knowledge Scale (ADKnowl), Self-Efficacy Scale for Chronic Diseases (SECD6), Self-Management Behavioral Scale for Diabetic Patients (SDSCA), and Diabetes-Specific Quality of Life Scale (DSQL). A total of 2,010 valid questionnaires were collected (91.66% response rate). Based on the Integrated Theory of Health Behavior Change (ITHBC), we constructed a conceptual model and performed multiple linear regression analyses to examine the impact pathways of ADKnowl and SECD6 scores on SDSCA and DSQL scores, controlling for confounders including gender, age, occupational status, education level, marital status, annual income, and diabetes complications.

Results: Mean scores were ADKnowl 52.5$\pm$16.5, $SECD66.4\pm1.2, SDSCA37.9\pm6.9, andDSQL48.3\pm8.6.Mul$
$0.05), withSECD6showingasignificantmediatingeffectof0.012(P <$
$0.05), accountingfor7.1 = 0.352)anddiet(= 0.161)knowledgepositivelypredictedSDSCAscores(P <$
$0.05), whileknowledgeaboutreducingcomplicationrisk(= -0.213), exercise(=$
$-0.117), anddiet(= -0.197)negativelypredictedDSQLscores(P < 0.05).Bothsymptommanagementself-efficacy(= -0.115)anddiseaseco - managementself - efficacy($=-0.397)$
negatively predicted DSQL scores (P<0.05).

Conclusion: Diabetes knowledge significantly improves self-management and quality of life among rural T2DM patients, with self-efficacy and self-management serving as important mediators. Specifically, knowledge about diet, exercise, and foot care substantially enhances patient outcomes. We recommend multisectoral collaboration, sustained health education, and enhanced social support resources to improve healthcare professionals' attention to patients' knowledge and self-efficacy, ultimately strengthening self-management behaviors and quality of life for rural diabetes patients.

Keywords: Diabetes mellitus, type 2; Knowledge; Self efficacy; Self-management; Quality of life; Root cause analysis; Mediation analysis

Introduction

China has the largest number of type 2 diabetes mellitus (T2DM) patients globally. Rural areas face unique challenges, including a high proportion of elderly residents, low education levels, weak disease prevention awareness, and uneven distribution of medical resources, which result in insufficient health service capacity and inadequate disease prevention and control measures. Consequently, rural diabetes patients exhibit significantly lower self-management levels and quality of life compared to urban patients and face higher mortality risk.

Diabetes knowledge refers to information and understanding about diabetes and its management, while self-efficacy encompasses confidence in one' s knowledge and skills, motivation, and belief in one' s ability to achieve behavioral goals in specific contexts. Research demonstrates that accumulating diabetes knowledge helps patients accurately assess their capabilities and limitations, reduces disease-related isolation and anxiety, improves mental health, and enhances self-efficacy. This knowledge also enables proper use of glucometers and mobile applications for self-management and improves quality of life, particularly among empty-nest middle-aged and elderly patients. Conversely, patients with high self-efficacy demonstrate greater confidence in daily self-monitoring and medication adjustment, leading to increased emphasis on self-management, greater participation in self-management and social activities, and improved health-related quality of life. Furthermore, patients with better self-management more easily control their diabetes and reduce its adverse impact on daily life. Thus, self-efficacy may mediate the pathway from diabetes knowledge to self-management, while both self-efficacy and self-management may mediate the pathway from diabetes knowledge to quality of life. However, these pathways have received insufficient scholarly attention.

The Integrated Theory of Health Behavior Change (ITHBC) provides an appropriate theoretical framework for examining relationships among diabetes knowledge, self-efficacy, self-management, and quality of life, particularly the mediating roles of self-efficacy and self-management. The theory comprises three core concepts: knowledge and beliefs, self-regulation capabilities, and social facilitation. While existing diabetes self-management research often employs the Information-Motivation-Behavioral Skills Model or Health Belief Model, ITHBC uniquely integrates cultural beliefs, individual behaviors, and quality of life factors. It emphasizes that diabetes knowledge not only directly affects self-management and quality of life but also indirectly influences self-management behaviors through self-efficacy, which subsequently impacts quality of life. This model provides a scientifically rigorous framework emphasizing process-oriented pathway analysis for diabetes health behavior research. Therefore, this study first constructed conceptual frameworks based on ITHBC theory to examine pathways from diabetes knowledge to self-management and quality of life, then investigated these relationships among rural T2DM patients in East China, and finally analyzed the specific effects of different dimensions of diabetes knowledge and self-efficacy on self-management and quality of life to inform rural chronic

disease management policy.

Methods

Study Design and Participants This cross-sectional study surveyed rural T2DM patients in Binhai County, Yancheng City, Jiangsu Province in August 2022. The research team randomly selected two townships—Caiqiao and Zhenghong—as designated sample areas using the township health center chronic disease management database, which contains basic information and physical examination results for patients with chronic diseases including T2DM. Inclusion criteria were: (1) rural household registration, (2) age $ $18 years, and (3) confirmed T2DM diagnosis based on medical records. Exclusion criteria included cognitive impairment or psychiatric disorders affecting communication. The study was approved by the Nanjing Medical University Ethics Committee [Approval No.: Nanjing Medical University Ethics Review (2022)].

Measures We administered four validated scales widely used in chronic disease research:

1. **Diabetes Patient Knowledge Scale (ADKnowl):** Assesses patient knowledge about diabetes and its management across eight dimensions: treatment, condition changes, hypoglycemia, exercise, reducing complication risk, smoking/alcohol consumption, foot care, and diet. The scale contains 26 items with 111 sub-items, scored 1 for correct answers and 0 for incorrect/unclear responses. Cronbach' s $\alpha = 0.91$.
2. **Self-Efficacy Scale for Chronic Diseases (SECD6):** Measures diabetes self-efficacy across symptom management and disease co-management dimensions with six items rated 1-10, where higher scores indicate greater confidence. Cronbach' s $\alpha = 0.88$.
3. **Self-Management Behavioral Scale for Diabetic Patients (SDSCA):** Assesses self-management practices across diet planning, physical exercise, blood glucose monitoring, foot care, and medication adherence dimensions with ten items rated 0-7 (higher scores indicate better self-management, except for reverse-scored items). Cronbach' s α ranges from 0.62-0.92 across dimensions.
4. **Diabetes-Specific Quality of Life Scale (DSQL):** Evaluates quality of life across 27 items and four dimensions measuring adverse effects of diabetes on physiological function, psychological function, social relationships, and treatment. Items are rated 1-5 using reverse scoring, where higher scores indicate greater adverse impact and poorer quality of life. Cronbach' s $\alpha = 0.95$.

Theoretical Framework In the ITHBC theoretical model, both diabetes knowledge and self-efficacy are crucial factors influencing self-management behaviors and quality of life. Based on ITHBC, we constructed a conceptual model

comprising two pathways: Model 1 examined the effect of diabetes knowledge on self-management with self-efficacy as a mediator; Model 2 examined the effect of diabetes knowledge on quality of life with both self-efficacy and self-management as mediators [Figure 1: see original paper].

Survey Administration and Statistical Analysis Questionnaires were administered by trained investigators in collaboration with family doctors to ensure accuracy. A total of 2,010 valid questionnaires were collected (91.66% response rate). We used SPSS 26.0 and Stata 15.0.0 for data analysis. Descriptive statistics were presented as relative numbers for categorical data and ($\bar{x}\pm s$) for normally distributed continuous data. Group comparisons of SDSCA and DSQL scores used t-tests for two groups and one-way ANOVA for multiple groups. Following our theoretical framework and controlling for confounders (gender, age, occupational status, education, marital status, annual income, and diabetes complications), we conducted multiple linear regression analyses with diabetes knowledge and self-efficacy as independent variables and self-efficacy, self-management, and quality of life as dependent variables to obtain regression coefficients and calculate indirect and mediating effects. Finally, we examined the effects of specific dimensions of diabetes knowledge and self-efficacy on self-management and quality of life through multiple linear regression analysis, controlling for the same confounders. Statistical significance was set at $P<0.05$.

Results

Patient Characteristics Among the 2,010 T2DM patients, 731 (36.37%) were male and 1,279 (63.63%) female; 673 (33.48%) were <65 years old and 1,337 (66.52%) $ $65 years; 1,255 (62.44%) were unemployed, 706 (35.12%) employed, and 49 (2.44%) retired. Education levels were predominantly junior high school or below (1,853 patients, 92.19%) versus high school or above (157, 7.81%). Most were married (1,677, 83.43%) versus unmarried/divorced/widowed (333, 16.57%). Annual income distribution was: <5,000 yuan (1,425, 71.04%), 5,000-10,000 yuan (380, 18.91%), 10,000-50,000 yuan (171, 8.51%), and >50,000 yuan (31, 1.54%). Diabetes complications were present in 1,307 patients (65.02%) and absent in 703 (34.98%).

Scale Scores Mean scores were ADKnowl 52.5$\pm$16.5, $SECD$66.4$\pm$1.2, $SDSCA$37.9$\pm$6.9, $and DSQL$48.3$\pm$$8 For ADKnowl, the highest correct rate was for reducing complication risk (60.94%), while smoking/alcohol consumption, exercise, and condition changes showed lower correct rates (29.73%, 31.89%, and 32.00%, respectively). DSQL dimension scores indicated greater adverse impact on physiological and psychological function, but less impact on social relationships .

Comparisons by Patient Characteristics SDSCA scores differed significantly by gender, age, occupational status, marital status, and annual income ($P<0.05$). DSQL scores differed significantly by gender, age, occupational status, education level, annual income, and diabetes complications ($P<0.05$) .

Pathway Analysis Multiple linear regression results showed: ADKnowl significantly predicted SECD6 (β=0.109, P<0.001) and SDSCA (β=0.156, P<0.001); SECD6 significantly predicted SDSCA (β=0.114, P<0.001) and DSQL (β=-0.377, P<0.001); SDSCA significantly predicted DSQL (β=-0.079, P<0.001).

Model 1: ADKnowl' s direct effect on SDSCA was 0.156 (P<0.05). SECD6 significantly mediated this relationship (indirect effect=0.012, P<0.05), accounting for 7.1% of the total effect (0.168).

Model 2: ADKnowl's direct effect on DSQL was -0.048 (P<0.05). Both SECD6 (indirect effect=-0.041) and SDSCA (indirect effect=-0.012) significantly mediated this relationship (both P<0.05), accounting for 40.6% and 11.9% of the total effect (-0.101), respectively [Figure 2: see original paper].

Dimension-Level Effects Further analysis revealed: (1) Foot care (β=0.352) and diet (β=0.161) knowledge positively predicted SDSCA scores (P<0.05), while smoking/alcohol consumption (β=-0.18), exercise (β=-0.059), and diabetes treatment (β=-0.134) knowledge negatively predicted SDSCA scores (P<0.05). (2) Knowledge about reducing complication risk (β=-0.213), exercise (β=-0.117), and diet (β=-0.197) negatively predicted DSQL scores (P<0.05), while foot care (β=0.147), condition changes (β=0.161), and diabetes treatment (β=0.119) knowledge positively predicted DSQL scores (P<0.05). (3) Both symptom management self-efficacy (β=-0.115) and disease co-management self-efficacy (β=-0.397) negatively predicted DSQL scores (P<0.05) but did not significantly predict SDSCA scores .

Discussion

Our findings reveal that while rural T2DM patients generally report adequate self-efficacy, their diabetes knowledge, self-management, and quality of life levels remain low, consistent with other Chinese cross-sectional studies. The mean ADKnowl score was less than half the total possible score, indicating poor mastery of diabetes management knowledge, particularly regarding smoking/alcohol consumption, exercise, and condition changes. This likely reflects limited information resources, low education levels, and constrained understanding among rural patients. We recommend intensified education and guidance on these specific knowledge areas.

Regarding self-management, rural patients showed higher overall self-management levels compared to urban community patients, but scored significantly lower on blood glucose monitoring and foot care. Economic constraints may prevent many low-income rural patients from affording glucose test strips and meters, limiting regular self-monitoring. Additionally, low education levels may hinder awareness and acquisition of foot care skills. For quality of life, compared with central and western rural regions, eastern rural patients experienced greater adverse effects on physiological and psychological

function but less impact on social relationships, possibly due to stronger family networks, community ties, and lower socioeconomic stress in eastern rural areas that help mitigate social concerns following disease onset.

Significant differences in self-management and quality of life emerged across gender, age, occupational status, marital status, and income groups. We recommend that primary healthcare institutions prioritize clear, accessible health education for rural women aged $ $65 years with annual income <5,000 yuan to effectively enhance their self-management capabilities and health status.

Model 1 results demonstrate that diabetes knowledge significantly promotes self-management, aligning with existing research. The Chinese Diabetes Management Guidelines emphasize that primary healthcare institutions should help rural patients improve diabetes knowledge through health education courses, enabling better understanding of risk factors and complications and motivating proactive self-management behaviors. The results also indicate that diabetes knowledge enhances self-management through self-efficacy, likely by improving psychological states such as reducing anxiety and strengthening disease-coping confidence, thereby enhancing emotional regulation and adaptation. However, the mediating effect of self-efficacy was relatively small (7.1% of total effect), suggesting that diabetes knowledge primarily exerts direct effects on self-management among rural patients, with indirect effects through self-efficacy being less prominent. Therefore, beyond public health education, we recommend leveraging family doctors to guide patients toward online resources and support groups to further enhance knowledge and self-management. Additionally, strengthening social support and medical resource allocation in rural areas provides foundational conditions for improving health behaviors.

Model 2 results show that diabetes knowledge significantly promotes quality of life, consistent with previous research. Adequate knowledge helps rural patients identify early warning signs of complications, manage their condition effectively, reduce acute complications like glycemic fluctuations, and improve quality of life. Notably, self-efficacy demonstrated substantial mediation (40.6% of total effect), indicating that while direct effects of knowledge on quality of life are important, indirect effects through self-efficacy must not be overlooked. This finding reinforces ITHBC' s emphasis on knowledge and attitudes in predicting health behaviors and outcomes. As diabetes knowledge increases, patients are more likely to feel capable and confident in taking necessary actions, thereby improving quality of life. Additionally, self-management behavior mediated 11.9% of the total effect, as enhanced knowledge facilitates positive self-management behaviors that reduce glycemic fluctuations and medical interventions, ultimately improving quality of life.

Dimension-specific findings reveal that foot care and diet knowledge showed strong positive associations with self-management, likely because these areas are closely connected to daily life, involve high participation, and require relatively simple knowledge that is accessible to rural patients. Providing clear, actionable guidance on healthy eating and foot care could substantially im-

prove self-management behaviors. Knowledge about reducing complication risk, exercise, and diet showed strong associations with quality of life improvement, possibly because understanding early symptoms and risk factors enables earlier preventive measures, while exercise knowledge helps reduce cardiovascular risk and enhance glycemic control. Therefore, village committees, community centers, and primary healthcare institutions should prioritize health lectures on foot care, dietary management, complication prevention, and exercise for rural diabetes patients. Furthermore, both symptom management and disease comanagement self-efficacy dimensions demonstrated significant positive effects on quality of life.

This study' s strengths include its use of the ITHBC framework to construct and empirically test pathway models, analyzing both direct and indirect effects of diabetes knowledge on self-management and quality of life while examining mediating roles of self-efficacy and self-management. Our findings highlight the need for heightened attention from health authorities to the low levels of diabetes knowledge, self-management, and quality of life among rural T2DM patients. Diabetes knowledge positively impacts self-management and quality of life, with self-efficacy playing a crucial mediating role. We recommend enhanced health education and management for rural T2DM patients in China through multisectoral collaboration, increased fiscal investment in diabetes prevention and management, and implementation of targeted health education programs using community centers, primary healthcare institutions, and village committees as platforms, supplemented by smartphone applications and multimedia channels. Providing necessary medical equipment, enhancing healthcare professionals' diabetes management capabilities, and fostering patient self-efficacy will improve treatment plan execution and confidence, ultimately reducing complications and enhancing quality of life.

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Note: Figure translations are in progress. See original paper for figures.