Postprint of the Chinese Adaptation and Reliability and Validity Testing of the Diabetes Self-Care Index Scale

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Abstract

Background: Diabetes is difficult to cure and has a prolonged disease course. The level of self-care is crucial for disease outcomes and health endpoints in diabetic patients. There is an urgent need for a comprehensive theory-guided assessment tool for diabetes self-care levels to timely grasp patients' self-care status and implement precision nursing accordingly.

Objective: This study aims to translate the Self-Care of Diabetes Inventory (SCODI) into Chinese and examine the reliability and validity of the Chinese version of SCODI, providing a scientific assessment tool for self-care among Chinese diabetic patients.

Methods: The Brislin translation model was used to translate the original SCODI into Chinese, followed by cultural adaptation. A consecutive sampling method was employed to select 261 diabetic patients from the First Affiliated Hospital of Nanjing Medical University and the Affiliated Yifu Hospital between December 2022 and June 2023 for the survey. Data were collected using a general information questionnaire developed by the researchers and the revised Chinese version of SCODI. Exploratory factor analysis was used to evaluate the structural validity of the Chinese version of SCODI. Cronbach's α coefficient, split-half reliability, and composite reliability were used to describe the reliability of the scale. This study used the physiological indicator glycated hemoglobin as a criterion to test the criterion-related validity of the Chinese version of SCODI, and Spearman rank correlation analysis was used to explore the correlation between the Chinese version of SCODI scores and glycated hemoglobin levels.

Results: The Chinese version of SCODI comprises 4 subscales with a total of 40 items: the self-care maintenance score was $(75.94\$\pm13.15), theself -$

$care monitoring score was (70.65 \pm 18.71), the self-care management score was (69.16 \pm 18.24), and the self-care confidence score was (85.41 \pm \$13.63)$. The self-care maintenance subscale extracted 4 factors (complication screening, exercise, health care, diet and medication), the self-care monitoring subscale extracted 2 factors (physical monitoring, symptom recognition), the self-care management subscale extracted 2 factors (autonomous management, consultation management), and the self-care confidence subscale extracted 2 factors (confidence in monitoring and management, confidence in health maintenance). The Cronbach's α coefficient for the total Chinese version of SCODI was 0.915, the split-half reliability was 0.836, and the composite reliability was 0.912, with the Cronbach's α coefficients for the 4 subscales ranging from 0.709 to 0.908. Using the physiological indicator glycated hemoglobin as the criterion, the scores of each subscale were significantly negatively correlated with glycated hemoglobin levels (rs=-0.160, -0.300, -0.177, -0.192, P<0.001).

Conclusion: The Chinese version of SCODI, developed based on the middle-range theory of self-care of chronic illness, demonstrates good reliability and validity and can be used to assess the self-care levels of Chinese diabetic patients.

Full Text

The Reliability and Validity of the Chinese Version of Self-care of Diabetes Inventory

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Abstract

Background: Diabetes mellitus is a chronic, incurable disease with a prolonged course. The level of self-care is crucial for disease outcomes and health endpoints in patients with diabetes. There is an urgent need for a comprehensive, theory-guided assessment tool to evaluate diabetes self-care levels, enabling healthcare providers to monitor patients' self-care status and deliver targeted, precision nursing interventions.

Objective: This study aimed to translate the Self-care of Diabetes Inventory (SCODI) into Chinese and examine the psychometric properties of the Chinese

version, providing a scientifically validated assessment tool for self-care among Chinese patients with diabetes.

Methods: The Brislin Translation Model was employed to translate the original SCODI into Chinese, followed by cultural adaptation. Using consecutive sampling, 261 patients with diabetes were recruited from the First Affiliated Hospital and the Affiliated Sir Run Run Hospital of Nanjing Medical University between December 2022 and June 2023. Data were collected using a self-developed general information questionnaire and the revised Chinese version of SCODI. Exploratory factor analysis was conducted to evaluate structural validity. Cronbach's α coefficient, split-half reliability, and composite reliability were used to assess reliability. Glycosylated hemoglobin (HbA1c) was used as a physiological criterion to evaluate criterion-related validity, with Spearman's rank correlation analysis examining the relationship between SCODI scores and HbA1c levels.

Results: The Chinese version of SCODI comprises 4 subscales with 40 items: self-care maintenance (75.94$\pm$13.15), $self-caremonitoring(70.65\pm18.71), self-caremanagement(69.16\pm18.24), andself - careconfidence(85.41\pm\$13.63)$. Factor analysis extracted four factors for self-care maintenance (complication screening, exercise, hygienic care, diet-medication), two factors for self-care monitoring (physical monitoring, symptom identification), two factors for self-care management (autonomous management, consultative management), and two factors for self-care confidence (monitoring and management confidence, health maintenance confidence). The Cronbach's α coefficient for the total scale was 0.915, split-half reliability was 0.836, and composite reliability was 0.912. Subscale Cronbach's α coefficients ranged from 0.709 to 0.908. Using HbA1c as the criterion, significant negative correlations were found between subscale scores and HbA1c levels (rs = -0.160, -0.300, -0.177, -0.192; $P < 0.001$).

Conclusion: Based on the middle-range theory of self-care of chronic illness, the Chinese version of SCODI demonstrates strong psychometric properties and serves as a valid and reliable instrument for assessing self-care levels in Chinese patients with diabetes.

Keywords: Diabetes mellitus; Self-care; Self-Care of Diabetes Inventory; Reliability; Validity; Middle-range theory of self-care of chronic illness

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Background

According to the International Diabetes Federation (IDF) Diabetes Atlas, China currently has the largest number of patients with diabetes worldwide, accounting for one-quarter of the global adult diabetes population [1]. In recent years, the prevalence of both type 1 and type 2 diabetes in China has continued to rise. In 2021, over 140 million Chinese adults had diabetes, and this number

is projected to exceed 174 million by 2045 [2]. As a chronic, incurable disease with a prolonged course, diabetes requires lifelong self-care to maintain stable blood glucose levels and control disease progression. Long-term monitoring, management, and treatment pose significant challenges to self-care adherence [3]. The American Association of Diabetes Educators identifies seven essential self-care behaviors: healthy eating, physical activity, blood glucose monitoring, medication adherence, problem-solving skills, healthy coping, and risk reduction [4]. Previous studies have demonstrated that high-quality self-care can effectively reduce healthcare costs, improve quality of life, enhance disease prognosis, and decrease complication risks in patients with diabetes, while also positively impacting depression and diabetes distress [5-8]. However, a national cross-sectional survey found that self-care among Chinese adults with diabetes is suboptimal, with only 4.4% achieving guideline-recommended physiological targets and merely 5.1% meeting lifestyle modification goals across smoking cessation, alcohol limitation, physical activity, and sleep [9]. Consequently, a scientifically comprehensive tool is urgently needed to assess diabetes self-care levels, enabling healthcare providers to understand individual patients' self-care status and adjust treatment plans accordingly to deliver personalized, precision nursing care.

Numerous instruments are available to assess self-care abilities or behaviors in diabetes [10], but most measure only a single dimension, such as diet, activity, or blood glucose monitoring. The two most commonly used multidimensional tools—the Summary of Diabetes Self-Care Activities (SDSCA) and the Self-Care Inventory-Revised (SCI-R)—were both developed before 2005, lack timeliness, and were created without explicit theoretical frameworks [11], relying instead on clinical experience and lacking scientific rigor. The Self-care of Diabetes Inventory (SCODI) was developed based on the latest clinical recommendations and demonstrates high content validity [12]. Grounded in the middle-range theory of self-care of chronic illness [13], SCODI measures behavioral dimensions including self-care maintenance, self-care management, and self-care monitoring, covering the entire process of health promotion and continuity in self-care. Additionally, SCODI integrates psychological factors influencing diabetes self-care from previous research into the self-care confidence dimension, making it the first theory-based diabetes self-care assessment tool that comprehensively incorporates psychological factors [11]. Therefore, this study translated and culturally adapted the SCODI and examined its reliability and validity among Chinese patients with diabetes to provide a scientifically sound tool for assessing self-care levels in this population.

Methods

1.1 Introduction to SCODI Developed by Italian scholar Ausili et al. in 2017 [14], SCODI consists of 40 items across four subscales: self-care maintenance (12 items), self-care monitoring (8 items), self-care management (9 items), and self-care confidence (11 items). These subscales were formulated

based on the core concepts and assumptions of the middle-range theory of self-care of chronic illness proposed by American scholars Riegel et al. [13]. Self-care maintenance refers to behaviors that patients with chronic illness adopt to maintain physiological and psychological stability, which can be decided independently or in consultation with healthcare providers. Self-care monitoring involves observing changes in signs and symptoms. Self-care management encompasses responses to observed signs and symptoms. Self-care confidence influences self-care maintenance, monitoring, and management, reflecting patients' self-efficacy, ability to perform specific tasks, and capacity to overcome difficulties in maintaining behaviors. The scale uses a 5-point Likert scoring system: self-care maintenance, monitoring, and management subscales range from 1 (never) to 5 (always), while self-care confidence ranges from 1 (not at all confident) to 5 (very confident). No total score is calculated; instead, each dimension score is computed as the sum of its items and then standardized. In the self-care maintenance subscale, only insulin-injecting participants respond to item 29. Currently, SCODI has been translated into multiple languages by scholars from 13 countries including the UK, Poland, and South Korea (www.self-care-measures.com), demonstrating good reliability and validity with Cronbach's α coefficients of 0.81, 0.84, 0.86, and 0.89 for the four subscales, respectively.

1.2 Translation and Cultural Adaptation

1.2.1 SCODI Translation After obtaining authorization from the original authors Ausili and Riegel via email, the English version of SCODI was translated into Chinese following the Brislin translation model [15]. The process involved: (1) Forward translation and synthesis: Two Chinese researchers proficient in English (a nursing lecturer with a doctoral degree obtained overseas and an English lecturer without medical background) independently translated the scale, producing forward versions 1 and 2. The researchers integrated these translations, discussing discrepancies with both translators to reach consensus and form a synthesized forward version. (2) Back-translation and synthesis: Two Singaporean nursing research assistants unfamiliar with the original scale independently back-translated the synthesized forward version into English, producing back-translation versions 1 and 2. A third English professor compared these versions repeatedly to create a synthesized back-translation version. (3) Pre-test Chinese version development: The synthesized back-translation version was sent to the scale developer Ausili for review. Based on the original author's feedback and suggestions, revisions were made until the Chinese version expressed consistent meaning with the original scale, resulting in the pre-test Chinese version of SCODI.

1.2.2 Cultural Adaptation Expert consultation was conducted with two endocrinology specialists, one diabetes specialist nurse, one community general practitioner, one community nurse, and two psychology experts. Using a 4-point Likert scale (1 = not relevant, 4 = strongly relevant), experts evaluated each

item's semantics and relevance to its dimension based on professional theoretical knowledge and clinical experience, providing modification suggestions to form the initial Chinese version of SCODI.

1.2.3 Pre-survey In October 2022, nine diabetic outpatients meeting inclusion criteria were conveniently selected for the pre-survey. Each patient completed the initial scale independently or with researcher assistance, followed by standardized interviews to assess understanding of concepts, meanings, and language expression. Results showed that participants understood all items and provided accurate, reliable responses, leading to the final Chinese version of SCODI.

1.3 Survey Implementation

1.3.1 Participants Using consecutive sampling, patients with diabetes were recruited from the endocrinology departments of the First Affiliated Hospital and the Affiliated Sir Run Run Hospital of Nanjing Medical University between December 2022 and June 2023. For exploratory factor analysis, the sample size should be 5-10 times the number of scale items [16]. The Chinese version of SCODI contains four subscales, with self-care maintenance having the most items (12). Therefore, the required sample size ranged from 60-120 cases. Considering potential attrition, 20% additional cases were included, yielding an estimated sample size of 72-144 cases.

Inclusion criteria: (1) Age $>$ 18 years; (2) Confirmed diabetes diagnosis for at least 6 months; (3) Abbreviated Mental Test (AMT) score $>$ 6; (4) Chinese reading or communication ability. **Exclusion criteria:** (1) Psychiatric diagnosis or current use of anti-anxiety/anti-depressant medication; (2) Severe complications such as heart failure, severe infection, or malignant tumors.

1.3.2 Survey Instruments Data were collected using a self-developed general information questionnaire and the revised Chinese version of SCODI. The general information questionnaire included 18 items covering gender, age, diagnosis duration, HbA1c, BMI, marital status, education level, medication status, and complications. The Chinese SCODI contains four subscales with 40 items, each using a 5-point Likert scale. Subscale scores are calculated as the sum of item scores and standardized to a 1-100 scale for comparability, with higher scores indicating better self-care.

1.3.3 Data Collection Online questionnaires were the primary data collection method, supplemented by paper forms. The research team conducted the survey after receiving standardized training. Before distribution, participants received written information about researcher identity, study purpose, and data anonymity/confidentiality, and provided informed consent. Completed questionnaires were reviewed for logical inconsistencies. A total of 320 questionnaires were distributed, with 261 valid questionnaires returned (81.6% response rate).

1.3.4 Reliability and Validity Testing Methods **Item Analysis:** The critical ratio method assessed item discrimination. The 261 questionnaires were sorted by total score, with the top 27% defined as high-scoring group and bottom 27% as low-scoring group. Independent samples t-tests compared differences between groups on each item. Items with statistically significant differences ($P < 0.05$) were retained, while non-significant items ($P \geq 0.05$) were deleted [17]. Correlation analysis examined consistency between items and overall scale content, calculating correlation coefficients between each item and its subscale total score. Items with correlation coefficient $r < 0.200$ or non-significant ($P \geq 0.05$) were removed [17].

Validity Testing: Exploratory factor analysis evaluated structural validity. KMO test and Bartlett's sphericity test determined data suitability for factor analysis (KMO > 0.6 and significant Bartlett's ^{2}, $P < 0.05$). Principal component analysis with varimax rotation extracted factors with eigenvalues > 1.0. Scree plots assisted in determining the number of factors. Items with factor loadings ≥ 0.4 were retained, while those with loadings < 0.4 were deleted [18]. HbA1c served as the criterion for criterion-related validity, with Spearman's rank correlation analysis examining relationships between Chinese SCODI scores and HbA1c levels. $P < 0.05$ indicated statistical significance; correlation coefficients rs of 0.400-1.000 indicated good item association and overall discrimination [19].

Reliability Testing: Cronbach's α coefficient, split-half reliability, and composite reliability assessed internal consistency. Generally, split-half and composite reliability > 0.7 [17], total scale Cronbach's $\alpha > 0.8$, and subscale Cronbach's $\alpha > 0.6$ [20] indicate acceptable reliability.

1.4 Statistical Analysis SPSS 26.0 software was used for data analysis. General information was described statistically: categorical data as frequencies and percentages; normally distributed continuous data as ($\bar{x} \pm s$), non-normally distributed data as $M(P_{25}, P_{75})$. Cronbach's α, split-half reliability, and composite reliability assessed reliability; structural validity and criterion-related validity assessed validity. $P < 0.05$ indicated statistical significance.

Results

2.1 Cultural Adaptation and Pre-survey Results Based on forward translation, back-translation, original author review, expert consultation, and pre-survey findings, the following modifications were made: (1) **Expression format:** Examples in the original scale (e.g., item 1 "specific forms of active lifestyle," item 6 "specific measures to avoid illness") retained bracketed format consistent with the original. (2) **Cultural differences:** In item 4 "avoid foods high in salt and fat," examples like cheese and bacon (rarely consumed in Chinese diets) were replaced with common foods such as animal oil and cured meats. For item 5 "limit alcohol intake," measurement unit "1 glass" was supplemented with metric explanations considering Chinese drinking culture. (3)

Inaccurate wording: Item 7 “avoid secondhand smoke” was revised to “avoid tobacco smoke” per original author suggestion. In the self-care management subscale, future tense was corrected to present tense per author feedback. After cultural adaptation and pre-testing, no items were deleted, and all dimension-item correspondences remained unchanged.

2.2 General Information of Respondents Among the 261 patients with diabetes, 146 (55.9%) were male and 115 (44.1%) were female, with mean age (49.8$±$15.8) years. Median HbA1c was 7.6% (6.5%, 10.0%). Type 2 diabetes predominated (75.9%). Other general information is presented in Table 1 .

2.3 Item Analysis Results Chinese SCODI scores were: self-care maintenance $(75.94\$\pm13.15), self-caremonitoring(70.65\pm18.71), self-caremanagement(69.16\pm18.24), andself-careconfidence(85.41\pm\$13.63)$. Item scores are shown in Table 2 . Correlation analysis revealed item-dimension correlation coefficients of 0.501-0.937 ($P < 0.001$) and item-subscale correlation coefficients of 0.408-0.787 ($P < 0.001$). Independent samples t-tests showed statistically significant differences between high and low scorers across all 40 items ($P < 0.01$), indicating all items should be retained for further analysis.

2.4 Validity Test Results

2.4.1 Exploratory Factor Analysis Factor analysis was conducted separately for each of the 40 items across four subscales. The self-care maintenance subscale showed KMO = 0.674 and Bartlett's $^2 = 713.644$ ($P < 0.01$), indicating suitability for factor analysis. Four factors with eigenvalues > 1 were extracted, with scree plot confirming a four-factor structure. Factor loadings ranged from 0.419-0.896 (all > 0.400) with no cross-loadings except item 3, which loaded on factor 2 (0.479) and factor 4 (0.604). The four factors explained 11.956%-17.891% of variance, with cumulative variance contribution of 59.874%, confirming a four-dimensional structure consistent with the original scale.

The self-care monitoring subscale (KMO = 0.756, Bartlett's $^2 = 719.224$, $P < 0.01$), self-care management subscale (KMO = 0.822, Bartlett's $^2 = 430.409$, $P < 0.01$), and self-care confidence subscale (KMO = 0.903, Bartlett's $^2 = 1468.5$, $P < 0.01$) each extracted two factors using the same method. No cross-loadings occurred, confirming two-dimensional structures for each subscale. Subscale scores and factor analysis results are presented in Table 2.

2.4.2 Criterion-Related Validity Results Significant negative correlations were found between Chinese SCODI subscale standardized total scores and HbA1c levels ($P < 0.001$). Correlation coefficients are detailed in Table 3 .

2.5 Reliability Test Results The Chinese SCODI total scale demonstrated Cronbach's $\alpha = 0.915$, split-half reliability = 0.836, and composite reliability = 0.912. Subscale Cronbach's α coefficients were: self-care maintenance 0.709, self-care monitoring 0.801, self-care management 0.815, and self-care confidence 0.908 (all > 0.700). A comparison of reliability between Chinese and original SCODI versions is shown in Table 4 .

Discussion

3.1 Good Discrimination of Chinese SCODI Item analysis revealed statistically significant differences between high and low scorers across all 40 items ($P < 0.001$), with significant correlations between item scores and corresponding dimension/subscale scores ($P < 0.001$). These results indicate excellent item discrimination, enabling the Chinese SCODI to identify self-care levels in patients with diabetes and provide a robust basis for personalized interventions to delay disease progression and prevent complications.

The highest scores were observed in self-care confidence, while the lowest appeared in self-care management, suggesting that patients believe in their ability to perform self-care and maintain health, yet many fail to follow medical guidance effectively. As Rezaei et al. [21] demonstrated, patients with diabetes often distrust medical guidelines, basing medication adherence solely on their physical condition. Sohal et al. [22] noted that non-adherent patients frequently misunderstand treatment, believing that reducing doses or skipping medications minimizes adverse effects, or that traditional medicine is safer than Western medicine. These findings underscore the need for enhanced multifaceted patient education to improve compliance and self-care effectiveness.

3.2 Good Validity Exploratory factor analysis confirmed the structural validity of Chinese SCODI. The self-care maintenance subscale extracted four factors: complication screening, exercise, hygienic care, and diet-medication, aligning with the original scale's dimensions. Item 3 (balanced diet) showed cross-loading on exercise and diet-medication factors. Since balanced diet is unrelated to exercise, and its loading was higher on the diet-medication factor (0.604 vs. 0.479), combined with evidence that dietary adherence significantly impacts glycemic control [23], item 3 was retained in the diet-medication dimension per expert recommendation.

The self-care management subscale extracted two factors: autonomous management and consultative management, consistent with the original dimensions but with some item allocation differences. The original scale categorized behaviors such as checking blood glucose when symptomatic (item 21), consuming sugar for hypoglycemia (item 24), and re-checking glucose after adjustment (item 27) as basic recommendations for autonomous management [14], while complex behaviors requiring experience and knowledge (e.g., recording abnormal glucose causes [item 22], seeking advice from professionals [items 23 and 28], adjusting diet/exercise/medication) were assigned to consultative management. In

this study, items about seeking advice (items 23 and 28) loaded on consultative management, while remaining items—regardless of decision-maker—loaded on autonomous management, as patients implemented adjustments themselves. This pattern may reflect the popularization of diabetes education and internet-based health resources in China, which have improved health literacy and enabled independent self-care behaviors [24]. Thus, the item allocation in this specific cultural context may be more appropriate than the original.

The self-care monitoring subscale extracted two factors (physical monitoring and symptom identification) with item allocation matching the original. The self-care confidence subscale also extracted two factors (monitoring and management confidence, health maintenance confidence) consistent with the original scale. Overall, exploratory factor analysis confirmed that Chinese SCODI maintains the original dimensional structure with all factor loadings > 0.400, demonstrating good structural validity.

HbA1c is the internationally recognized gold standard for glycemic monitoring, reflecting self-care effectiveness. Research has confirmed significant correlations between self-care and HbA1c [25]. Chinese SCODI subscale scores showed significant negative correlations with HbA1c (rs = -0.300 to -0.160). Although correlation coefficients were modest, the significant relationships—potentially attenuated by criterion representativeness—indicate acceptable criterion-related validity.

3.3 Good Reliability Reliability testing showed Chinese SCODI total and subscale Cronbach's α, split-half reliability, and composite reliability all exceeded 0.7, indicating good item intercorrelation. Notably, the self-care confidence subscale showed higher Cronbach's α than the original version, suggesting superior reliability in this dimension for the Chinese version. These results confirm that Chinese SCODI is a reliable measurement tool.

3.4 Good Application Prospects Self-care is a lifelong endeavor for patients with diabetes. The "Healthy China 2030" blueprint emphasizes "active health" to promote universal health, advocating for proactive discovery, scientific assessment, and health promotion [26]. A valid and reliable measurement tool enables patients to scientifically evaluate their self-care and helps healthcare providers comprehensively understand patients' self-care levels to predict disease progression and improve adherence [27]. Chinese SCODI, with strong psychometric properties, is the first theory-based diabetes self-care assessment tool integrating psychological factors. It encompasses all components of the middle-range theory (maintenance, monitoring, management), addressing limitations of existing Chinese tools—such as lack of theoretical foundation, narrow dimensions, and outdated content—providing a comprehensive method for clinical assessment. Research indicates self-care confidence is a key predictor of self-care levels [28], and Chinese SCODI's confidence dimension can identify psychological factors affecting self-care, enabling investigation of relationships

between confidence and self-care processes.

The scoring method standardizes each subscale to 1-100 points, allowing both comprehensive assessment across subscales and dimensional comparisons. This facilitates communication between clinicians and patients, enhances understanding of self-care status, and provides scientific evidence for developing intervention plans. This study translated and culturally adapted SCODI, demonstrating its reliability and validity among Chinese patients with diabetes. Future research should expand sample sizes and examine applicability across type 1 and type 2 diabetes populations to provide scientific evidence for self-care research in China.

Author Contributions: TANG Xiaorui performed statistical analysis, created tables, and drafted the manuscript. XU Jingjing designed the study, coordinated implementation, and revised the manuscript. GU Zijun, WANG Qingyu, and ZHU Qiurui conducted the research and collected data. LIN Zheng designed the study and revised the manuscript. LEI Yang conceptualized the study, designed the protocol, and is responsible for the manuscript.

Conflicts of Interest: None declared.

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