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Psychometric properties of the Comprehensive Diabetes Self-Management Scale in patient with diabetes

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Abstract

This study's objective was to investigate the psychometric characteristics of the "Comprehensive Diabetes Self-Management Scale," which was created by Mikhael et al. This scale provides a comprehensive screening tool for health promotion-oriented behaviors. With the involvement of 475 diabetic people, the study was undertaken between January and August 2022. The study's sample was formed by taking more than 33 times the amount of items on the original scale (14 items). "Diabetes Self-Care Scale" was used as a parallel form to calculate reliability coefficients. The scale's confirmatory factor analysis showed a very good fit [x^2 (53, N=475) p=0.014; x^2/ degree of freedom=1.477; chi-square:78.276; root mean square error of approximation =0.032; comparative fit index =0.970; goodness-of-fit index =0.975] with the results obtained in the first level factorial structure of 13 items and five sub-dimensions. There was a 57.16% overall variance, it was found. The Comprehensive Diabetes Self-Management Scale was shown to be a valid and reliable measuring instrument for people with diabetes. This scale will provide the opportunity to evaluate many important concepts and behaviors related to diabetes with a single tool.

Keywords: comprehensive, reliability, self-management, type 2 diabetes, validity

1. Introduction

One of the most dangerous and prevalent chronic diseases of our day, diabetes poses a risk to life, impairs function, results in expensive complications, reduces life expectancy (1), and affects daily activities related to self-care (2). Diabetes is an important public health problem that is increasing worldwide. There are 537 million diabetics worldwide, according to figures from "The International Diabetes Federation" for 2021. Additionally, it is anticipated that by 2045, there will be 783 million people worldwide with diabetes, with Turkey having one of the top 10 global rankings for the number of people with Diabetes Mellitus (DM) diagnoses (3).

It is very important for patients to maintain their diabetes management with determination in preventing or delaying the complications that may develop due to DM. A self-management approach should be developed in diabetic patients in order for them to continue with this determination (4). For those who have lived with chronic illnesses for a long time and who routinely make self-management decisions or take steps to solve problems, self-management is an essential component of daily life (5). Self-management, which is the cornerstone of diabetes care, provides routine glucose assessment and adherence to therapy, as well as careful planning of physical activity and diet and coping with low/high glucose levels. Effective self-management of diabetes will contribute to the maintenance of strict glycemic control and hence lower the risk of diabetic complications (6). More intense efforts are required to ensure the adoption of quality diabetic self-care tools, given the rapid expansion and serious effects of diabetes on world health. Effective diabetic self-care measurement will help to improve diabetes management by detecting self-care gaps (7). These tools for assessing health-promoting habits will assist in determining patients' behaviors and aid in developing interventions. Different studies have been conducted internationally to examine diabetes self-management. Some of these scales include the 40-item "Diabetes Self-Care Inventory" (8), 35-item "Diabetes Self-Management Scale" (9), 8-item "Perceived Diabetes Self-Management Scale" (10), 16-item "Diabetes Self-Management Questionnaire" (11), is a 28-item "Type 2 Diabetes and Health Promotion Scale" (12). There are several validity and reliability research (13–17) on diabetes in our nation; however, there is no comprehensive tool to evaluate diabetes self-management techniques. When all the above references are summarized, it is observed that many

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important notions and attitudes are spread across different assessment tools. Important factors in glycemic control include exercise, diet, medication adherence, blood glucose testing, risk avoidance, stress management, foot care, and patient adherence on sick days (such as the flu, diarrhea, or urinary tract infections). However, Turkey has a limited selection of assessment tools that combine these factors. The Turkish validity and reliability study of the "Comprehensive Diabetes Self-Management Scale (CDSMS)" addresses this need in this area. This scale offers a quick, simple, useful, and comprehensive screening tool for activities aimed at promoting health. Therefore, it is crucial to carry out a study on the tool's validity and reliability.

2. Materials and Methods

2.1. Study design and sample selection

This study is methodological research conducted to investigate the psychometric properties of CDSMS developed (18) by Mikhael et al. The study was conducted on patients with type 2 diabetes mellitus (T2DM) admitted to a State Hospital in northern Turkey between January and August 2022. The study sample consisted of 475 individuals who (i) were older than 18 years, (ii) had T2DM, (iii) had been taking antidiabetic medication for at least three months, (iv) could speak/understand Turkish, (v) could communicate effectively with health care professionals, and (vi) gave consent to participate in the study. Our study had a sample size that was more than 33 times the amount of items on the 14-item measure. It is advised that the sample size for scale studies be ten or fifteen times the number of each scale item. (19, 20). In the study, the sample was first taken 15 times, and since the "Kaiser-Meyer-Olkin (KMO)" values were below 0.50, data collection continued. It is stated that 0.50 should be the lower limit for the KMO test (21).

2.2. Data collection tools

Sociodemographic information form, the CDSMS, and for the calculation of reliability coefficients Diabetes Self-Care Scale (DSCS) (2, 22) has been used.

Sociodemographic characteristics questionnaire

A sociodemographic information form created by the researchers in accordance with the literature was employed, taking the study's goals into account. This questionnaire asked people with T2DM questions about their gender, age, educational background, occupation, and the year of their diabetes diagnosis.

"Comprehensive diabetes self-management scale"

To evaluate diabetes self-management techniques unique to persons with diabetes, Mikhael et al. created the CDSMS in 2019. It consists of a total of 14 items, including exercise (items 1 and 2), diet (items 3, 4, and 5), medication adherence (item 6), blood glucose testing (item 7), reducing diabetes risks (items 8-11), coping with stress (item 12) and solving problems (items 13 and 14). The scale's ten items were created using a multiple-choice format with five possible responses.; 4 items (8, 9, 11, 14) were designed using a style with dichotomous answer sub-questions. The items are scored between 0 and 4; zero is assigned to the response with the least accepted practice, while 4 is assigned to the answer with the most approved practice for multiple-choice items and 1 for dichotomous questions. By summing the scores of each sub-question, the score of the items containing sub-questions was obtained. Every item is computed inversely, with the exception of items 3, 4, 5, 10, 11D, and 14 B (18).

"Diabetes Self-Care Scale"

The 35-item DSCS, which Karakurt translated into Turkish, is a Likert-style scale. This scale deals with individuals' self-care and self-evaluation. The scale has four options: 'Never,' 'Sometimes,' 'Frequently,' and 'Always.' High scores on the scale, which has a maximum possible score of 140, show that patients are competent and autonomous in providing for their own needs (22).

2.3. Translation and cultural adaptation

For linguistic validity, the scale was translated to Turkish by three people fluent in Turkish and English, considering the use of appropriate sentence structures and the replacement of items that are foreign to the culture. Then, the researchers created the Turkish scale by analyzing these three translations. A native speaker of both languages who had never seen the English version of the scale before then compared the original and final versions of the scale after being translated back into English. Following the back translation, the scale items underwent grammar, comprehensibility, and cultural traits revisions. For content and language validity reviews, the final translation was presented to 15 health professionals (academics, physicians, and nurses with a focus on diabetes). Each scale item was graded ('no important omission,' 'partially important omission,' 'unimportant omission') by the experts for its content validity using the Lawshe approach (23). "The content validity index (CVI)" for 14 items was determined to be 0.88 as a consequence of the expert judgments, and the final form of the scale was developed in accordance with their suggestions. Then, the scale was pre-administered, and individuals with T2DM were asked about their thoughts on the items and the comprehensibility of the items (conceptual questioning). Since there was no negative feedback, the data collection phase started.

2.4. Ethical considerations

"The Bartın University Ethics Committee" received ethical approval (2021-SBB-0473) for this work. The study's goal was explained to the individuals who decided to take part, and their signed informed permission was acquired. Additionally, the authors who developed the scales granted permission for their use in the study by email.

2.5. Statistical analysis

With the help of "Amos version 24" and "SPSS version 26", the study's data were examined. Kurtosis and Skewness values were analyzed to determine whether the research variables

were normally distributed. In the related literature, the results of kurtosis and skewness values of the variables between +1.5 and -1.5 (24), +2.0 and -2.0 (25) are accepted as normal distributions. It was determined that the variables showed normal distribution. Frequencies and means ± standard deviations were used to define sociodemographic and clinical parameters. Firstly, the data were assessed to see if they were appropriate for factor analysis using the KMO value and "Barlett Test." "Exploratory Factor Analysis (EFA)" was used to determine the relationship between the variables. To determine if the conceptual model identified by EFA was supported or not, "Confirmatory Factor Analysis (CFA)" was utilized. To verify the reliability, Pearson correlation analysis was employed. The internal consistency of the scale's overall and sub-dimensions was examined using Cronbach's alpha.

3. Results

The mean age of the participants was 59.03±12.86 years (min=18, max=86), the mean years of illness were 10.29±7.70, and the mean duration of antidiabetic drug use was 8.91±7.11. The participants were 58.8% female, 41.2% male, 46.9% primary school graduates, 12.9% illiterate, and 12% high school graduates. When their employment status was analyzed, it was found that 42.5% were housewives, and 36.8% were retired. It was discovered that 70.6% of the individuals had a genetic susceptibility to diabetes and a family history of the disease (Table 1).

Table 1. The sociodemographic characteristics of the patients

Sociodemographic characteristics		n	%
Gender	Female	279	58.8
	Male	196	41.2
Age	18-34	22	4.6
	35-54	127	26.7
	55-64	135	28.4
	65+	191	40.2
Job	Retired	175	36.8
	Officer	15	3.2
	Employee	47	9.9
	Housewives	202	42.5
	Unemployed	12	2.5
	Other	24	5.1
Education status	Illiterate	60	12.9
	Only literate	46	9.7
	Primary school	223	46.9
	Primary education	55	11.6
	High school	57	12.0
	University and above	34	7.2
Body Mass İndex (BMI)	Underweight	3	0.6
	Health Weight	75	15.8
	Overweight	173	36.4
	Obesity	224	47.2

3.1. Reliability analysis

In the study, KMO and Bartlett's tests were used to evaluate the sampling adequacy of the data set for factor analysis. The KMO test value of CDSMS was found to be within the measurable range of 0.621. "The Bartlett Sphericity" test revealed that the variables were significantly correlated with one another and that the data were appropriate for factor analysis (x^2: 915.113, degree of freedom (df): 91, p<0.000). EFA factor analysis of the CDSMS was conducted. Tabacknick and Fidell (26) took this cut-off point as 0.32. The factor loadings of the items in a factor in the study are expected to be at least 0.40. Since the 13th item had a factor loading of 0.192, it was removed from the analysis, and the analysis was repeated. The total variation reported by the 13 items and 5 sub-dimensions (respectively "diet," "exercise," "reducing the risks of diabetes," "diabetes management," and "mental risk factors") of the scale was 61.22% as a result of this study.

An important criterion of factor analysis is that the variance explained should exceed 50% of the total variance. Because the generated factor structure has a limited ability to reflect the universe if it explains less than half of the total variable variation. In addition, the sum of the eigenvalues is expected to be above 1 (27). In the EFA, Factor 1 (F1: diet) had an eigenvalue of 2.27 and explained variance of 17.43%, Factor 2 (F2: exercise) had an eigenvalue of 1.94 and explained variance of 14.96%, Factor 3 (F3: reducing the risks of diabetes) had an eigenvalue of 1.45 and explained variance of 11.12%, Factor 4 (F4: diabetes management) had an eigenvalue of 1.26 and explained variance of 9.72%, Factor 5 (F5: mental risk factors) had an eigenvalue of 1.04 and explained variance of 8.00%.

The item correlation coefficient was found to be 0.755-0.795 in sub-dimension F1, 0.893-0.898 in sub-dimension F2, 0.788-0.851 in sub-dimension F3, 0.368-0.720 in sub-dimension F4, 0.808-0.812 in sub-dimension F5 and it was determined that the reliability of the scale was good. The resulting factors are named, and the model representing the properties of this structure is tested with the help of CFA (28). Therefore, the identified factors were tested again with CFA (Table 2).

3.2. Structure Validity

The CFA 13 items and five scale sub-dimensions were found to have a very good fit with the results obtained in the first level factorial structure [x2 (53, N=475) p=0.014; x^2/df=1.477; Chi-square (CMIN):78.276; Root Mean Square Error of Approximation (RMSEA)=0.032; Comparative Fit Index (CFI)=0.970; Goodness-of-Fit Index (GFI)=0.975]. These findings demonstrate that the study's data are consistent with the organizational structure (five-factor model) that the CDSMS scale is expected to have (Fig.1).

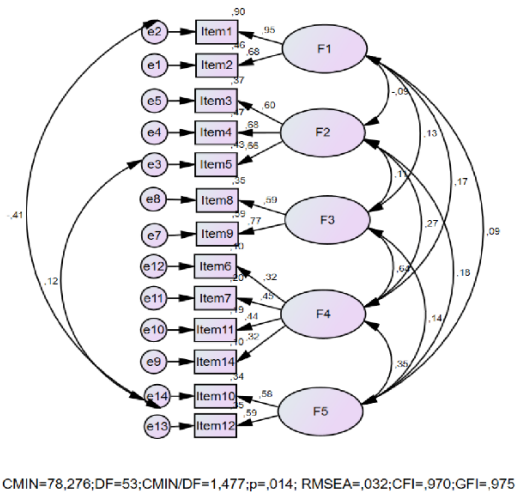

Fig. 1. First-level factorial structure of the Comprehensive Diabetes Self-Management Scale. CMIN: Chi-square; df: degree of freedom; RMSEA: Root Mean Square Error of Approximation; CFI: Comparative Fit Index; GFI: Goodness-of-Fit Index

When Table 3 is examined, x^2/df, RMSEA and Adjusted Goodness of Fit (AGFI), CFI, and GFI values show excellent fit, and Normed Fit Index (NFI) and Tucker-Lewis Index (TLI) show acceptable fit.

The findings suggest that the scale's original five-factor, 13-item format is also suitable for Turkish culture in terms of psychometric analysis.

The reliability coefficient is most frequently calculated in scale development and adaptation research using "Cronbach's alpha" (29). Cronbach's alpha was initially calculated for this reason. The total Cronbach Alpha of the scale was found to be 0.580. Cronbach's alpha for the F1, F2, F3, F4, and F5 sub-dimensions of the scale was 0.683, 0.785, 0.624, 0.407, and 0.511, respectively. The internal consistency coefficient Cronbach's alpha of the CDSMS scale was found to be lowly reliable for sub-dimensions F4 and F5 and highly reliable for sub-dimensions F1, F2, and F3.

Table 2. Exploratory factor analysis data of the Comprehensive Diabetes Self-Management Scale

Items	F1 (Diet)	F2 (Exercise)	F3 (Reducing the Risks of Diabetes)	F4 (Diabetes Management)	F5 (Mental Risk Factors)
Item 3*	.755				
Item 4*	.795				
Item 5*	.777				
Item 1*		.898			
Item 2*		.893			
Item 8*			.851		
Item 9*			.788		
Item 6*				.720	
Item7*				.510	
Item11*				.368	
Item14*				.681	
Item10*					.812
Item12*					.808
Eigenvalue*	2.27	1.94	1.45	1.26	1.04
Total Variance Explained (%61.22)*	17.43	14.96	11.12	9.72	8.00
Cronbach' alpha Total (.580) **	.683	.785	.624	.407	.511

*Factor Analysis, **Reliability Analysis

Table 3. Fit indices and scale values of The Comprehensive Diabetes Self-Management Scale

Fit indices	Perfect fit criteria	Scale values
$\chi 2$/df	≤ 2	**1.477**
p	≤ 0.05	**0.014**
RMSEA	≤ 0.05	**0.032**
AGFI	0.90 ≤	**0.958**
CFI	0.95 ≤	**0.970**
GFI	0.95 ≤	**0.975**
TLI	0.95≤	**0.955**
NFI	0.95≤	0.914
IFI	0.95≤	**0.971**

Confirmatory Factor Analysis
df: degree of freedom; RMSEA: Root Mean Square Error of Approximation; AGFI: Adjusted Goodness of Fit; CFI: Comperative Fit Index; GFI: Goodness-of-Fit Index; TLI: Tucker-Lewis Index; NFI: Normed Fit Index; IFI: Incremental Fit Index

In the study, the DSCS was used as a parallel form, which is another reliability criterion. Calculating the correlation coefficient between the data derived from these two parallel forms reveals if the parallel forms are equivalent (30). Depending on the data characteristics, Pearson correlation coefficients and equivalence coefficients are calculated (30). In the study, Pearson correlation analysis results between the two scales were found as (r:0.545; p=0.000). Although the equivalence coefficient varies between 0 and 1, being close to 1 indicates that the results obtained from parallel forms are reliable (31). These findings led to the conclusion that the CDSMS was reliable

4. Discussion

This study's objective was to evaluate the reliability and

validity of a brand-new tool for assessing diabetes patients' self-management. As a consequence, it has been shown that the CDSMS scale is reliable and acceptable in Turkish culture. It is expected to contribute to future research on this subject.

The CDSMS, originally in English and adapted to the Turkish population, was similar to the initial scale (14 items) in relation to sub-dimensions and a number of items. However, due to low factor loading within our analysis, the 13th item was eliminated. In addition, while the original scale had seven sub-dimensions and single-item sub-dimensions, the study consisted of 13 items and five sub-dimensions, with at least two items in each sub-dimension.

The homogeneous structure of the items is explained by "Cronbach's alpha coefficient," a metric of the items' internal consistency. The Cronbach's alpha coefficient is high when the items are consistent and contain items that measure the same trait. The literature has stated that this value should be more than 0.40 (32). In this study, the total Cronbach Alpha of the scale was found to be 0.580. The results of Cronbach's alpha for the scale's F4 and F5 sub-dimensions were found to be of low reliability, whilst those for the F1, F2, and F3 sub-dimensions were found to be fairly trustworthy. In our study, the sub-dimension encompassing behaviors related to physical activity (F2) had the greatest Cronbach's alpha coefficient (0.785), while the sub-dimension related to behaviors related to nutrition (F1) had a highly reliable Cronbach's alpha value (0.683). Similar findings were observed in the study by Chen et al., where it was discovered that Cronbach's alpha coefficient of the sub-dimension comprising dietary behaviors was 0.68 and that it was 0.86 for the sub-dimension including physical activity behaviors (12). In their analysis of the original scale's development, Mikhael et al. discovered that Cronbach's alpha coefficient was 0.704 (18). The fact that the scale in the study has a lower value than the original scale may be due to cultural factors. The dependability of the scale was further examined using a parallel scale. The parallel scale shows that the results obtained are reliable.

In more than one study in the literature, it is stated that 50% of the total variance explained is sufficient (27, 33, 34). Mankan et al. found that the total variance explained in the diabetes self-efficacy scale (8 items) was 52.38% (14). In the study of the type 2 diabetes self-management scale developed by Koç, it was detected that the 3-factor structure explained 50% of the total variance (17). In the study of Bakır et al. on the diabetic foot self-care behavior scale, it was found that the measurement tool consisting of 7 items explained 69.883% of the total variance (35). In the scale study developed by Chen et al., it was detected that the 28-item scale explained 56.7% of the total variance (12). Saffari et al. found that the scale was in the form of a structure explaining 54.6% of the total variance (36). Our study's total variance explained was determined to be 61.22%, and it is similar to other research on diabetes.

"The x^2/df ratio" [perfect fit (≤ 2.5-3)] should be as low as feasible for a good model fit. In the current research, x^2 /df =1.477, indicating a perfect fit. These findings were consistent with those of another Turkish study on validity and reliability that involved diabetic individuals (37).

The closer the RMSEA is to zero, the better the model-data fit (38). Since the RMSEA value was 0.032 in the study, there is a model-data fit. The CDSMS has strong internal consistency and steady dependability, as demonstrated by Mikhael et al. In their study, they reported that the scale is a reliable and valid tool and can be used to evaluate self-management practices among diabetic patients in their country (18). Similarly, our study concluded that the CDSMS is a reliable and valid tool that can be applied in the Turkish community.

The CDSMS scale raises intriguing questions about better diabetes management. Healthcare professionals and patients will have more detailed information through this scale. In addition, patients will be more aware of receiving these services (e.g., doctor's visits/regular tests) when certain tests are due. Moreover, this scale will provide an opportunity to examine many important concepts and behaviors in a single assessment tool.

When all of the data is taken into account, it is believed that the CDSMS scale is a valid and reliable measuring tool that can be applied and will close the gap in this area. To improve its evidential value, it is advised that it be used in many cultures and groups. In addition, in order to provide evidence for the validity and reliability of the Turkish version of the CDSMS Scale, the findings of this study should be supported by new studies that will include more samples.

Ethical Statement

"The Bartın University Ethics Committee" received ethical approval (2021-SBB-0473) for this work. The study's goal was explained to the individuals who decided to take part, and their signed informed permission was acquired. Additionally, the authors who developed the scales granted permission for their use in the study by email.

Conflict of interest

The authors declare that they have no conflict of interest.

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Authors' contributions

Concept: Y.Ş.Y., B.A., H.Y.D., Design: Y.Ş.Y., B.A., H.Y.D., Data Collection or Processing: Y.Ş.Y., B.A., Analysis or Interpretation: Y.Ş.Y., B.A., H.Y.D., Literature Search: Y.Ş.Y., B.A., Writing: Y.Ş.Y, B.A.

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