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Research Article

Psychometric Evaluation of the Korean Version of PROMIS Self-Efficacy for Managing Symptoms Item Bank: Item Response Theory

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S U M M A R Y

Purpose: To evaluate the psychometric properties of the Patient-Reported Outcomes Measurement Information System (PROMIS) self-efficacy for managing symptoms of the version 1.0 item bank in Korea.
Methods: This study consisted of two phases: first, developing the Korean version of the item bank following the translation guidelines; and second, performing a cross-sectional study to evaluate its psychometric properties using the item response theory. This study enrolled 323 patients with type 2 diabetes mellitus between July and August 2020. Cronbach's α was used to assess the reliability of this item bank. Confirmatory factor analysis, using diagonally weighted least squares, was used to identify the assumptions of item response theory. Item parameter estimates including discrimination and thresholds were derived using the graded response model of the item response theory to reflect patient-reported outcomes as individualized responses.
Results: The Korean version of the item bank demonstrated good reliability (Cronbach's $\alpha = .98$) and its discrimination ranged from 1.82 to 4.93. The thresholds resulted in the establishment of a category response curve for each item. However, no overlap was observed among the category curves. Moreover, the differential item functioning was not significant for age, gender, and income variables.
Conclusion: The graded response model and differential item functioning provided qualitative evidence that demonstrated acceptable psychometric properties of symptom management self-efficacy among patients. This item bank is expected to provide adequate assessments of self-efficacy of symptom management for patients with a chronic disease, which can contribute to nursing research and intervention.

Introduction

The Patient-Reported Outcomes Measurement Information System (PROMIS) was established in 2004 to develop improved patient-reported outcomes (PRO) [1]. The multicenter collaborative PROMIS has produced more than 300 item banks within the physical, mental, and social domains. The PROMIS scales are advantageous for their high precision, which facilitates the assessment of a wide range of various aspects regarding patients' contexts. The information compiled by the PROMIS Health Organization has been translated into multiple languages and used worldwide [2]; thus, the study developed the PROMIS self-efficacy for managing symptoms item bank (version 1.0) in Korean, using the item response theory (IRT) and evaluated its psychometric properties.

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Abbreviations: CFA, Confirmatory Factor Analysis; CFI, Comparative Fit Index; COSMIN, Consensus-based Standards for the Selection of the Health Measurement Instruments; DIF, Differential Item Functioning; D-SMART, Diabetes Self-Management Assessment Report Tool; DWLS, Diagonally Weighted Least Squares; FACIT, Functional Assessment of Chronic Illness Therapy; GRM, Graded Response Model; HbA1c, hemoglobin A1c; IRT, Item Response Theory; PHO, PROMIS Health Organization; PRO, Patient-Reported Outcomes; PROMIS, Patient-Reported Outcomes Measurement Information System; RMSEA, Root Mean Square Error of Approximation; SDSCA, Summary of Diabetes Self-Care Activities Questionnaire; TLI, Tucker-Lewis Index.

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The PRO is pertinent for establishing a scientific framework for patient experience in healthcare research [3,4]. The United States National Institutes of Health recognized the need for PRO measurement tools to ensure validity and reliability in high-quality care [1]. There has been a significant demand from patients for the expression and measurements of their “real” symptoms and experiences [5]. The PROMIS item banks from a physical category have been translated and validated more frequently than those in the psychosocial health categories [6,7].

The evaluation of self-care abilities among patients with chronic diseases is important for the maintenance, monitoring, and management of their medical information. According to the self-care of chronic illness theory, the improved management of chronic diseases results in positive self-care outcomes [8]. As shown by the health action process approach theory, initiating health-related behaviors, such as self-care, requires a *pre-intentional motivation process*. In a previous study, it was reported that self-efficacy had an effect on self-care in patients with chronic diseases such as heart failure, asthma, and hypertension [9–11]. Self-efficacy is relevant to this process, as it is the belief in one's own abilities to complete a task or achieve a goal [12,13]. Thus, self-efficacy for managing symptoms refers to a set of patients' beliefs about their ability to control their symptoms successfully.

The PROMIS self-efficacy scales for managing chronic conditions fall within the mental health category [14]. Patients are impacted by various needs and symptoms depending on their respective contexts; hence, evaluating patients can help to provide effective individualized care [15,16]. Standardized PRO measurements are necessary to evaluate the patients’ cultural backgrounds, which are done during psychometric evaluations. Standardizing PRO measurements is crucial because multiple understandings could arise from different cultural backgrounds, even in the same given sentence [17].

According to the evidence, chronic diseases have consistent guidelines that include symptoms management and complication prevention. However, treatment goals and management processes vary among patients [18,19]. With an understanding of the patients' integrative context, nurses should be able to make sound clinical judgments [20]. For instance, a previous scoping review study emphasized the increasing need for cross-cultural studies that analyze indicators of Diabetes Mellitus (DM) in the context of the patients’ life and experiences. Particularly, social factors can be considered in order to manage blood glucose levels [21]. Nurses' monitoring and intervention to manage chronic disease patients' symptoms make up a substantial axis of social factors. Thus, measuring self-efficacy for managing symptoms using the PROMIS self-efficacy scales is essential for patients with chronic disease.

Self-efficacy of patients with chronic disease for self-care and symptom management is a significant topic that has continuously piqued interest in healthcare [22–25], and instruments have been developed in response [26–28]. A systematic review of the self-efficacy instruments for patients with chronic diseases reported that most instruments had unclear purposes and measurement properties [29]. The widely used self-efficacy scale [30] is limited to general aspects of self-efficacy and not for assessment of patients' self-efficacy in managing symptoms. There is a need to assess patients’ psychological readiness for the management of complications or acute exacerbations through the incorporation of voluntary self-care strategies. The PROMIS self-efficacy for managing symptoms item bank assesses self-efficacy in a variety of domains, ranging from daily symptom management activities to strategies for coping with unexpected changes.

The original PROMIS item banks were developed using the IRT model [31,32]. The IRT analysis highlighted the functions of each item and encompassed the characteristics of items in the whole measurement [33]. With regard to measuring, IRT is concerned with the item of measurement, whereas classical test theory depends on the entire measurement [34]. Using IRT, it is possible to determine how each item contributes to a total measurement and how each item performs on the measurement [35]. Each PROMIS item bank measures specific categories and domains and is considered a one-factor model [6,36]. The PROMIS seeks to expand the understanding of patients’ experiences by using item banks in the global healthcare domain. Therefore, developing the PROMIS item bank in a different language through strict and systematic methods can help generate individualized PRO evidence.

This study aimed to develop the PROMIS self-efficacy to manage symptoms using the version 1.0 item bank that has been translated and adapted culturally to Korean. Furthermore, to investigate psychometrics using the IRT model for patients with type 2 DM.

Methods

Design

This is a methodological study designed to evaluate the validity and reliability of the Korean version of PROMIS self-efficacy for managing symptoms item bank (version 1.0) with original data from the survey.

The current study comprises two main phases. First, the Korean version of PROMIS self-efficacy for managing symptoms item bank was developed. The details of the first step are described in the following section, “Translation including cross-cultural context.” Second, a cross-sectional study was conducted to evaluate the psychometric properties of the final version of the Korean item bank. After the survey, raw data was analyzed using the IRT model, in accordance with the reporting checklist for PROMIS [37]. Furthermore, this study adhered to the *Strengthening the Reporting of Observational Studies in Epidemiology* (STROBE) guidelines [38].

Translation process and validation

The license agreement to translate the PROMIS self-efficacy for managing symptoms item bank (version 1.0) into Korean was obtained from the PROMIS Health Organization (PHO). The PHO presented the guidelines for translation and development. Figure 1 presents an overview of the translation process. The translation process followed the PROMIS translation guidelines based on the Functional Assessment of Chronic Illness Therapy (FACIT) translation methodology [39,40]. One of two independent Korean speakers translated the first version of the item bank, and the other reviewed the first version. A Korean-English bilingual translator back-translated the version, and three Korean speakers reviewed the back-translation. All the translators used during this process were healthcare providers. The research team finalized the translated item bank and reached a consensus with the PROMIS center. Thereafter, five Korean patients with type 2 DM were enrolled in the cognitive testing and linguistic validation process. The study research team reported the cognitive interview results to the PROMIS center. The final version of the Korean version of PROMIS self-efficacy for managing symptoms item bank was completed based on the cognitive interview report and discussion.

Sample/Participants

A total of 354 patients with type 2 DM were recruited using convenience sampling from the DM center of a tertiary hospital in Seoul, South Korea. The study participants were adults aged 19 and above and had volunteered to participate in completing the questionnaires between July and August 2020. We chose type 2 DM

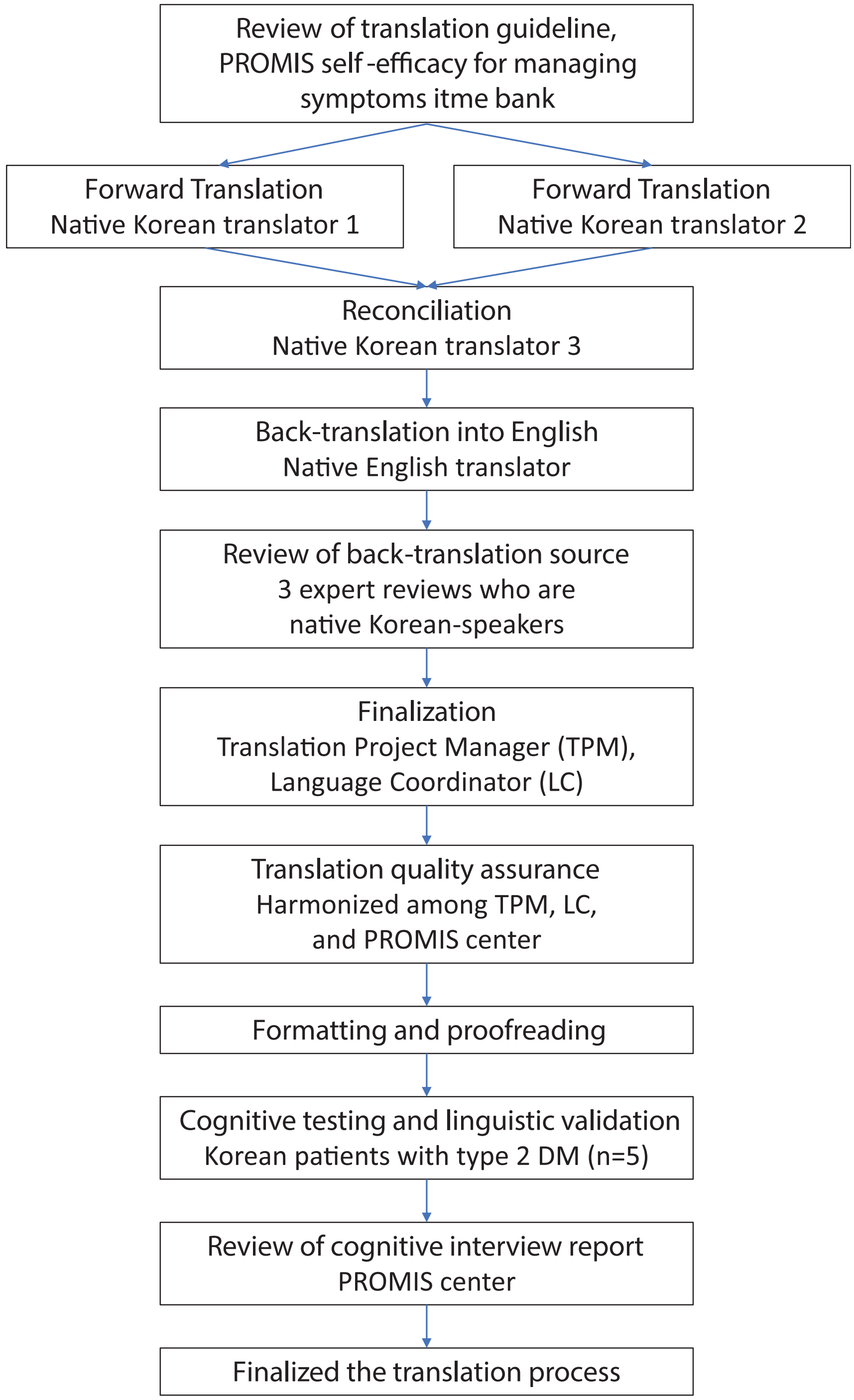

Figure 1. Translation Process of the Korean Version of PROMIS Self-efficacy for Managing Symptoms Item Bank. Note. PROMIS=Patient-Reported Outcomes Measurement Information System, DM = Diabetes Mellitus.

patients as the study population. The first reason is to reduce participant heterogeneity and to control exogenous variables for psychometric evaluation. Second, DM is one of the most common chronic diseases that can be treated and managed with regular evaluations and treatments such as diet, physical activity, and medication [41]. It thus becomes vital for patients with type 2 DM to manage symptoms through medication and treatment [42].

A total sample of 323 patients (91.2%) completed the survey, and thus were included in the study utilized. Confirmatory factor analysis (CFA) was used to test the assumptions of the IRT model. The minimum sample size for CFA was 200 cases [43], with a previous study reporting that the IRT model can be applied to at least 200 patients depending on the model complexity in healthcare research [44]. Moreover, the sample size used in this study exceeded the minimum criterion for the IRT model.

Data Collection

Instrument

The main instrument used was the PROMIS self-efficacy for managing symptoms version 1.0 item bank for adults, which includes 28 items. A five-point Likert scale was used to assess the responses, ranging from a scale of "1 = not at all confident" to "5 = very confident." A higher score implies an increased sense of self-efficacy in managing symptoms. This item bank measures patients' self-efficacy regarding the degree to which symptoms are controllable and the ability to prevent symptoms from worsening.

In addition, two measurements were used to analyze the convergent validity, namely the Diabetes Self-Management Assessment Report Tool (D-SMART) and the Korean version of the Summary of Diabetes Self-Care Activities Questionnaire (SDSCA), after approval from the original authors. These two instruments have established good validity and reliability in previous studies.

The original version of D-SMART was developed by the American Association of Diabetes Educators via Peyrot and colleagues to assess the self-management behavior of patients with DM [45]. The Korean version of D-SMART was used in previous studies [46,47]. Among the D-SMART questions, 23 items were used to evaluate the self-management skills confidence [45]. The evaluation of skills confidence for DM self-management behavior in seven categories, including exercise/activity, nutrition, medication, and monitoring, is conducted using a 4-point Likert scale, with higher scores indicating greater skills confidence. In this study, Cronbach's alpha value of scale was 0.91.

Toobert and colleagues revised SDSCA in 2000, which is used mainly in self-management activity studies for patients with DM and consists of 25 items, including six subscales: general and specific diet, exercise, blood sugar test, foot care, and smoking [48]. Chang and Song (2009) translated and modified the revised SDSCA in Korean and it has 17 items, excluding eight items that could not be scored [49], and five domains—diet, exercise, medication, blood sugar test, and foot care—were included [50]. This measurement asks participants to indicate on an 8-point scale ('0 day' to '7 days'), the number of days they engaged in self-care activities corresponding to each item during the previous week. Cronbach's alpha for the Korean version of this study was as follows: 0.58 for diet, 0.80 for diet, 0.36 for medication, 0.92 for blood sugar test, and 0.63 for foot care.

Assumptions of the IRT

The IRT model requires several robust assumptions, namely: *unidimensionality, invariance, local independence,* and *monotonicity* [43]. First, the CFA and coefficient omega (ω_h) were used to analyze *unidimensionality* and *invariance* [51,52]. The criteria of the CFA results of *unidimensionality* required the comparative fit index (CFI) or Tucker-Lewis Index (TLI) to exceed .95 or root mean square error of approximation (RMSEA) to be less than 0.06 [51]. In addition, the results of ω_h were used to assess *unidimensionality* [52]. The generally accepted criterion for ω_h is .70 [53]. Second, the chi-square (χ^2) value assessed whether the model was fit for *invariance*. When the *p*-value of χ^2 was not statistically significant, it was considered an appropriate model fit [51]. Confirming the assumption with χ^2 is a theoretical concept, and every case does not meet the χ^2 assumption. When χ^2 was not satisfied, it could be assumed that each subgroup has a varied differential item functioning (DIF) [35]; therefore, age, gender, and income were selected as the anchor variables to confirm the DIF in this study. Thirdly, using Yen's Q3, *local independence* was tested by residual correlations [54]. A study reported that *local independence* did not have a single critical value [55]. However, based on previous research and consensus-based standards for the selection of the health measurement instruments (COSMIN) manual for systematic reviews of PROMs, this study established criteria: <0.37 is suitable, and <0.7 is considered possible [51,56]. Finally, *monotonicity* was supported by an adequate graph of discrimination and thresholds [51,57].

Data analysis

The data was analyzed using SPSS (version 25.0; IBM, Armonk, NY, USA) and the *lavaan, psych, mirt,* and *lordif* packages in *R* version 4.1.2. A descriptive statistical test was performed for the demographic and clinical variables. Univariate normality was confirmed before analysis to identify the selection bias of the study. Cronbach's α coefficients were used to confirm the reliability of the measurements. This study applied diagonally weighted least squares (DWLS) to determine the CFA results using the *lavaan* package in *R,* because the item bank was an ordinal variable, and the ceiling effect was identified [58,59]. The ω_h were estimated using the *psych* package, and the residual correlation was tested using *mirt* package in *R*.

T-score

Following the PROMIS scoring guide, the standardized T-score was used in this study [21]. T-score is a standard score of reference samples including United States (U.S.) general population [31]. The underlying T-score of the self-efficacy for managing symptoms item bank was calibrated to reach an average of 50, with a standard deviation of ±10 for the U.S. clinical sample. The PROMIS center provides the PROMIS T-score maps on the website for some short-form item banks. The T-score was obtained using the website of the Health Measures Scoring Service (powered by the Assessment Center℠) that provides underlying item parameters and scoring for the U.S.

IRT model

This study used the graded response model (GRM) of the IRT model because the item bank has ordered categories, such as the Likert scale [43]. For the GRM, discrimination and thresholds were estimated, and category response curves were derived. The IRT model was implemented to reflect the patients' ability level for psychometric evaluation using the *mirt* package in *R* [43,60].

Differential item functioning

The DIF was analyzed to evaluate the validity of this item bank, which was constructed using a five-point Likert ordinal scale. Three group variables, including age, gender, and income, were used to analyze whether each question functions differently between groups. Among the group variables, the age group was divided into under 60 years [61] and above, with a male gender group as a reference. The income group was divided into less than four million South Korean won [62] and more.

The *lordif* package used the ordinal logistic regression model for DIF estimating methods [38]. The DIF analysis was conducted in two steps. First, the likelihood ratio χ^2 test was carried out without using the anchor item. Second, the DIF item was extracted from 28 items. The DIF can be categorized as either a uniform DIF (if the effect is constant) or a non-uniform DIF (if the effect varies depending on the trait level) [63,64]. The χ^2 difference test (df = 1) was conducted for each of the two types of DIF using logistic regression. The overall χ^2 difference test (d*f* = 2) for the total DIF was identified for the two inclusive types of DIF effect. A significance level of .01 was used as the criterion for each χ^2 test. Thereafter, the DIF was evaluated using the items that were not extracted during the first step as anchor items. In this step, at least 2.0% of the items within McFadden's pseudo R^2-change were extracted as a DIF [65].

Results

Demographics and clinical characteristics

The average age of the patients was 62.16 ± 10.54 years, with a DM period of 14.23 ± 10.33 years in this study. Male patients made up 68.4% of the participants, and the majority of the participants were married (91.6%). Monthly income was reported as less than four million South Korean won by 52.3% of participants and as more than four million South Korean won by 47.7% of participants. The participants' average Body Mass Index (BMI) was 25.11 ± 3.57 kg/m^2, ranging from 16.60 to 42.82 kg/m^2. The average recent hemoglobin A1c (HbA1c), which measures the amount of glucose attached to hemoglobin, was 7.5 ± 1.5% according to patients' electronic health records. The majority of participants (90.1%) managed their DM through oral administration, 33.4% via insulin injection, and 26.9% through a combination of medication and insulin. Most of the participants did not receive DM group education (77.4%) and managed their DM through administering oral medications (90.1%).

Item analysis

In total, 28 items were analyzed using mean and standard deviation (Table 1). Considering the criteria that the average value should be between 1.5 and 4.5 on a five-point Likert scale, all items were within the range [66]. The patients in this study reported moderate self-efficacy for managing symptoms (T = 52.6, SD = 8.25). The T-Score differed merely by two points as compared to the T-score derived for the general U.S. population. Baseline self-efficacy for managing symptoms (T = 51.38, SD = 8.353) improved after two weeks of follow-up (T = 53.82, SD = 7.98).

Reliability and convergent validity

The Cronbach's α of this item bank was .98 (Table 1). All measures met the reliability criteria (>.70). In addition, if the items were deleted, lower levels of Cronbach's α would be observed as opposed to the total Cronbach's α (Table 1).

Table 1 *Item Analysis of the Korean Version of PROMIS Self-Efficacy for Managing Symptoms Item Bank (n = 323).*

Item	Mean ± SD	Cronbach's α if deleted
SEMSX001	3.53 ± 1.16	.98
SEMSX002	3.68 ± 1.07	.98
SEMSX003	3.17 ± 1.26	.98
SEMSX004	3.89 ± 1.05	.98
SEMSX005	3.74 ± 1.11	.98
SEMSX006	3.93 ± 1.05	.98
SEMSX007	4.18 ± 0.88	.98
SEMSX008	3.88 ± 1.01	.98
SEMSX009	3.72 ± 1.14	.98
SEMSX010	3.95 ± 1.01	.98
SEMSX011	3.89 ± 1.02	.98
SEMSX012	3.90 ± 1.05	.98
SEMSX013	3.77 ± 1.09	.98
SEMSX014	3.93 ± 1.01	.98
SEMSX015	3.84 ± 1.08	.98
SEMSX016	3.79 ± 1.05	.98
SEMSX017	3.85 ± 1.03	.98
SEMSX018	3.85 ± 1.07	.98
SEMSX019	3.73 ± 1.08	.98
SEMSX020	3.90 ± 1.03	.98
SEMSX021	3.73 ± 1.14	.98
SEMSX022	3.86 ± 1.02	.98
SEMSX023	2.85 ± 1.03	.98
SEMSX024	2.73 ± 1.08	.98
SEMSX025	2.73 ± 1.08	.98
SEMSX026	2.89 ± 1.03	.98
SEMSX027	2.73 ± 1.14	.98
SEMSX028	2.86 ± 1.02	.98
Total mean ± SD		105.13 ± 23.38
Minimum − Maximum		35 − 140
Coefficient α (Cronbach's α)		.98
Coefficient omega (ω_h)		.87
Total T-score Mean ± SD		52.6 ± 8.25
Baseline T-score Mean ± SD		51.38 ± 8.53
Follow-up T-score Mean ± SD		53.82 ± 7.98

Note. SD = standard deviation.

This study tested convergent validity using the D-SMART and the revised SDSCA. The correlation coefficients of the item bank and D-SMART was r = .59 ($p < .001$). However, there was no statistical significance between the item bank and each domain of revised SDSCA: diet 0.11 (p = .054), exercise 0.11 (p = .059), medication −0.02 (p = .731), blood sugar test 0.05 (p = .420), and foot care 0.03 (p = .633).

Assumptions and the expected scores curves for the IRT

First, *unidimensionality* was the primary assumption for IRT [43,67]. For this study, the CFA results were verified by applying the DWLS. As PROMIS item banks were developed as a unidimensional model [68,69], we determined the *unidimensionality* by conducting CFA to test the convergent validity without exploratory factor analysis [70]. The estimation result of χ^2 ($df = 350$) was 8809.65, and the model did not perfectly fit the data ($p < .001$). Both CFI and TLI of the Korean version of the item bank were 0.99 which met the criteria [51,71,72] but the RMSEA, 0.274, did not. As the COSMIN methodology for PRO measures [51] recommends that either CFI/TLI or RMSEA should be satisfied with the criteria for *unidimensionality*; thus, the *unidimensionality* of the Korean version of the item bank was identified. In addition, these results comply with the recommended value ω_h for this item bank, which was .87 (Table 1). Second, the p-value of $\chi^2 > .01$ provides an appropriate criterion for the *invariance* model fit. The χ^2 value of this item bank was 8809.649 ($p < .001$). Therefore, we determined the value of DIF to verify the *invariance* [35]. Using age, gender, and income as anchor items, a DIF analysis was conducted, and the results confirmed that this model showed *invariance*. Third, the results of residual correlation among the items as a unidimensional model using Yen's Q3 were less than 0.37, except for the residual correlation between items 1 (SEMSX001) and 2 (SEMSX002), which ranged from −0.24 to 0.33 [51]. The residual correlation between items 1 and 2 was estimated to be 0.51, and a previous study confirmed *local independence* [56]. Lastly, all category response curves indicated an adequate monotonic relationship between the item thresholds and participants' self-efficacy ability. These inform the *monotonicity* of the basic assumptions for IRT. Figure 2 displays the example of the category response curve for item 22.

Estimating graded response model

The GRM evaluated item discrimination (a) and thresholds (b) based on participants' response patterns regarding the IRT model (Table 2). Overall, the discrimination of this item bank was high, ranging from 1.82 to 4.93. The threshold values in the item bank were estimated in the order of low to high values according to the GRM (Table 2). For item 11, no patient selected the first category. Thus, the threshold of item 11 was analyzed using only four categories, from the initial two to five. When identifying the category response curve derived using the estimated item parameter, the category curve did not indicate complete overlap with another curve. The figures of the 28 items were interpreted to ensure that each item category had appropriate functions. An example of item 22 (SEMSX022) is shown in Figure 2.

Analyzing the DIF

This study used three group variables for DIF analysis: age, gender, and income.

First, as a result of conducting the likelihood ratio χ^2 test using the age group variable, items 1 (SEMSX001), 21 (SEMSX021), and 27 (SEMSX027) had DIF. Items 1 and 21 represented the non-

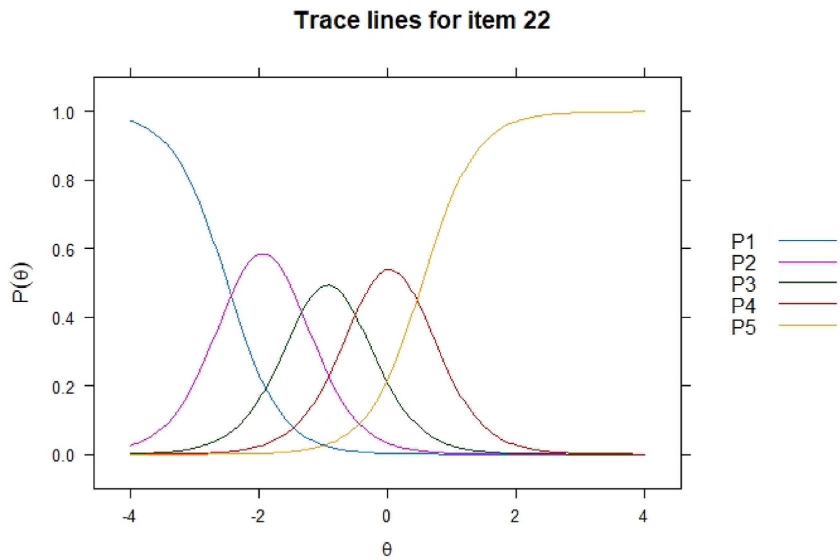

Figure 2. Category Response Curve of the Korean Version of PROMIS Self-Efficacy for Managing Symptoms Item Bank Item 22 (SEMSX022). The graphs of P1 to P5 are Likert scale scores, one to five, of the item 22.

Table 2 *Estimated Item Parameters for the Korean Version of PROMIS Self-Efficacy for Managing Symptoms Item Bank Using the Graded Response Model.*

Item	Discrimination *a* (SE)	Threshold			
		b_1 (SE)	b_2 (SE)	b_3 (SE)	b_4 (SE)
SEMSX001	2.34 (.22)	−2.43 (.24)	−1.18 (.12)	−0.08 (.09)	.73 (.10)
SEMSX002	1.99 (.19)	−2.18 (.21)	−0.84 (.11)	.27 (.09)	1.15 (.13)
SEMSX003	2.52 (.23)	−2.62 (.28)	−1.10 (.12)	−0.27 (.08)	.64 (.10)
SEMSX004	1.82 (.17)	−1.98 (.20)	−0.86 (.11)	.15 (.10)	1.08 (.13)
SEMSX005	2.55 (.23)	−1.84 (.17)	−1.08 (.11)	−0.19 (.08)	.76 (.10)
SEMSX006	2.42 (.23)	−2.19 (.21)	−1.38 (.13)	−0.33 (.09)	.67 (.10)
SEMSX007	1.93 (.18)	−1.73 (.17)	−0.67 (.10)	.20 (.09)	1.07 (.13)
SEMSX008	3.21 (.30)	−2.44 (.23)	−1.36 (.12)	−0.51 (.08)	.30 (.08)
SEMSX009	2.68 (.25)	−2.26 (.21)	−1.22 (.12)	−0.37 (.08)	.48 (.09)
SEMSX010	3.48 (.33)	−2.37 (.22)	−1.31 (.12)	−0.52 (.08)	.26 (.08)
SEMSX011	3.50 (.35)	N/A	−1.62 (.14)	−0.88 (.10)	.13 (.08)
SEMSX012	3.37 (.31)	−2.50 (.25)	−1.38 (.12)	−0.55 (.08)	.37 (.08)
SEMSX013	2.52 (.24)	−2.30 (.22)	−1.10 (.11)	−0.43 (.09)	.50 (.09)
SEMSX014	3.50 (.33)	−2.23 (.21)	−1.41 (.13)	−0.56 (.08)	.30 (.08)
SEMSX015	4.20 (.40)	−2.22 (.20)	−1.30 (.11)	−0.48 (.08)	.33 (.08)
SEMSX016	4.93 (.48)	−2.10 (.18)	−1.29 (.11)	−0.49 (.08)	.32 (.07)
SEMSX017	4.75 (.45)	−2.05 (.17)	−1.23 (.11)	−0.51 (.08)	.29 (.07)
SEMSX018	3.46 (.32)	−2.21 (.21)	−1.25 (.11)	−0.43 (.08)	.36 (.08)
SEMSX019	3.50 (.32)	−2.11 (.19)	−1.14 (.11)	−0.44 (.08)	.43 (.08)
SEMSX020	4.20 (.40)	−2.44 (.25)	−1.27 (.11)	−0.55 (.08)	.28 (.07)
SEMSX021	3.33 (.31)	−2.28 (.21)	−1.18 (.11)	−0.50 (.08)	.35 (.08)
SEMSX022	2.39 (.23)	−2.50 (.25)	−1.37 (.13)	−0.47 (.09)	.54 (.09)
SEMSX023	2.30 (.22)	−2.85 (.34)	−1.44 (.14)	−0.53 (.09)	.45 (.09)
SEMSX024	2.57 (.24)	−2.25 (.22)	−1.33 (.13)	−0.62 (.09)	.43 (.09)
SEMSX025	2.90 (.27)	−2.22 (.21)	−1.21 (.12)	−0.40 (.08)	.53 (.09)
SEMSX026	4.57 (.43)	−1.99 (.17)	−1.30 (11)	−0.52 (.08)	.34 (.07)
SEMSX027	2.08 (.20)	−2.32 (.23)	−1.27 (.13)	−0.50 (.09)	.53 (.10)
SEMSX028	3.70 (.34)	−2.20 (.20)	−1.28 (.12)	−0.48 (.08)	.42 (.08)
Range	1.82 to 4.93	−2.85 to −1.73	−1.62 to −0.67	−0.88 to .27	.13 to 1.15

Note. N/A = Not applicable, SE = standard error.

uniform DIF, and item 27 described the uniform DIF. All three DIF items (1, 21, and 27) had statistical significance in the total DIF effect ($p < .001$). Ordinal logistic regression was conducted again with other items, except these three, as the anchor item. Consequently, item 27 was identified with a McFaddens' pseudo R^2-change of over 2.0% or more; the R^2-change value of uniform DIF was 3.4%, and the total DIF was 3.9% ($p < .001$). Figure 3 shows the test characteristic curves (TCC) of item 27. The effect of item 27 on the expected score of the entire item bank was interpreted to be minimal.

Next, the χ^2 test results according to the gender group variable were described. Item 27 had a uniform DIF ($p < .008$); however, the total DIF effect was not statistically significant ($p = .211$). After the ordinal logistic regression was re-conducted with the remaining items, excluding item 27, there was no item with McFadden's

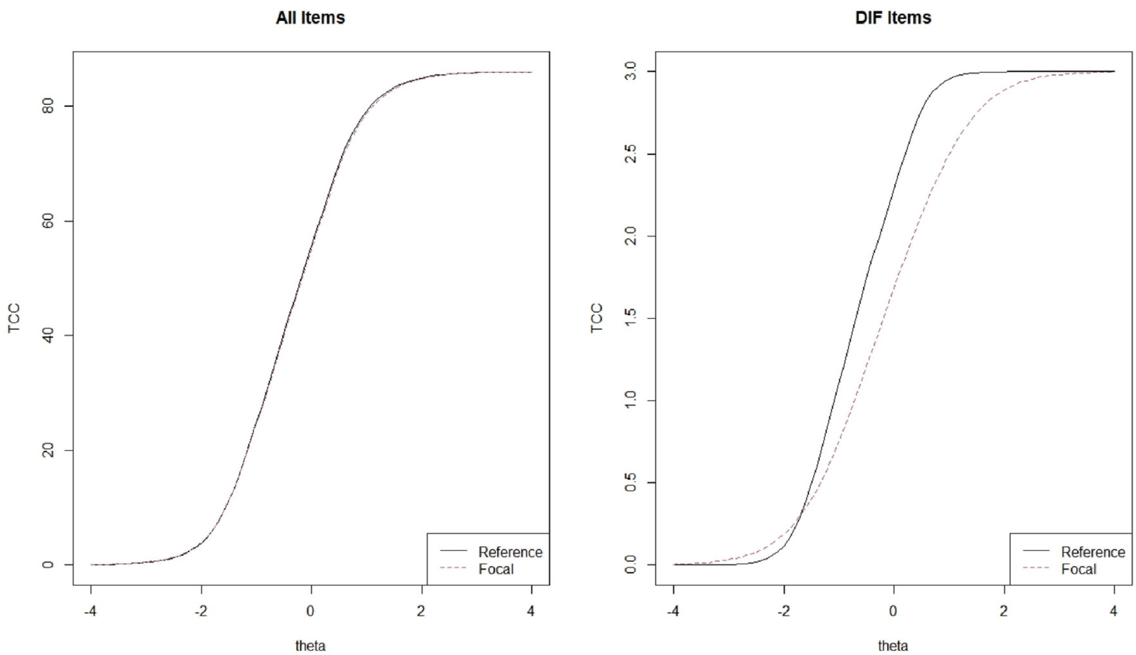

Figure 3. Test Characteristic Curves (TCC) for Age Differential Item Functioning (DIF) in the Korean Version of PROMIS Self-Efficacy for Managing Symptoms Item Bank. The TCC total consequence of DIF of all items is left graph; the TCC for item 27(SEMSX027) with negligible DIF is right graph. *Note.* DIF = differential item functioning.

pseudo R^2-change. Finally, the χ^2 test was conducted with the income group variable, and no item indicated the DIF.

Discussion

This study developed the Korean version of PROMIS self-efficacy for managing symptoms item bank. The PROMIS item banks are globally used instruments to assess self-reported patient outcomes, which include integrative factors that identify patients as individualized people [35]. Previous studies have translated psychometric evaluations into other languages using the IRT [73,74]. The IRT model underscores the functions of each item and outlines the item characteristics across the instrument [35,75]. Cleanthous and his colleagues verified that the IRT was suitable for PROMIS® measurement applications [76]. The IRT model was advantageous for measuring human abilities, attitudes, and other attributes using actual survey data.

Cronbach's α identified the reliability of this item bank as appropriate. This study used the D-SMART and the revised SDSCA to test convergent validity. The current item bank showed a significant correlation with D-SMART, which is evaluating the self-efficacy for self-management skills [70]. It indicates that the item bank was reliable and suited conceptually in terms of self-efficacy among participants of this study. On the contrary, none of the subdomains of the revised SDSCA, measuring self-care activities in the past week, showed statistical significance. A systematic review of measurements for self-care among DM patients reported that the revised SDSCA had low quality of comprehensiveness and comprehensibility [77]. This psychometric limitation of the revised SDSCA needs careful interpretation of the current result of convergent validity with the PROMIS item bank.

This study partially fulfilled the four basic IRT assumptions. The study adopted the COSMIN guidelines even though there was no absolute standard for the criteria of IRT assumptions. The CFA was conducted to validate the *unidimensionality* of the original PROMIS scale. Since the item bank comprised ordinal data, the DWLS was selected for the estimation method in this study [35]. A small sample of fewer than 200 participants may face an increased risk of an overestimated correlation using DWLS [58]. However, the number of participants in this study met this criterion (n = 326). The overall fit of this item bank fulfilled the requirements of the validity of CFA and supported the *unidimensionality* of CFI. The Root Mean Square Error of Approximation and Standard Root Mean Residual did not meet the inclusion criteria. These results implied the possibility that the Korean version of the PROMIS self-efficacy for managing symptoms item bank may possibly have a multiple factor structure. According to the original PROMIS item banks [31,32] as well as previous studies based on a psychometric evaluation of the PROMIS item banks, analyses were performed using a single factor model [2,52,76,78]. Since this study aimed to verify the results by applying PROMIS measurements to a Korean context, the IRT was performed without further modification of the items. Thus, further research is required to analyze the subcategories in the item bank across various settings and populations.

Data for this study was collected from the diabetes center at a tertiary hospital in Korea. The participants displayed effective outcomes with regard to DM control. For example, the HbA1c was 7.5 ± 1.5%, performing lower than that reported in previous studies [79,80]. In addition, over 90% of the participants controlled their glucose with oral medication. These results can result in the ceiling effect, indicating good control of their glucose levels. Ceiling effects negatively affect the CFA results [81]. This study was analyzed using the DWLS in consideration of the ceiling effect. Statistical calibration serves as one method to solve this problem; however, the flooring or ceiling effects need to be considered when developing psychological evaluation tools such as self-efficacy instruments.

As a result of the psychometric evaluation using the IRT model in this study, the Korean version of PROMIS self-efficacy for managing symptoms was a suitable instrument. The discrimination (a) range of the Korean version of this item bank was from 1.82 to 4.93. All the category response curves of the items were independent. The proper item showed discrimination that exceeded zero, indicating that the higher the values, the better the associated discrimination [43]. In a previous study that analyzed the PROMIS self-efficacy for managing daily activities item bank through the IRT model, discrimination was scored between 1.90 and 4.03 [82]. This is similar to the present study. The independent category response curves derived from the threshold (*b*) values indicated that the scale of the item (five-point Likert scale) had its own traits [43]. The results of category response curves suggest that each item of the Korean version of this item bank did not need to be tuned or revised.

The major strength of this study was that it identified the global utility of the PROMIS item bank of self-efficacy for managing symptoms. The DIF results, comprising subgroups of age, gender, and income, suggested that specific general characteristics did not interfere with the total item bank. Psychological measurements generally target participants from various contexts. Each item should function similarly for the same ability of participants [83]. In this study, item 27 was identified as the DIF in the age group variable. The test characteristic curve of item 27 (*I can find the information I need to manage my symptoms*), showed a negligible difference between the total and item 27 graphs. The confidence or ability to obtain health-related information was affected by the use and access level of digital devices [84,85]. Although there was no significant difference observed from the graph, item 27 reflected the increased tendency of health literacy toward using smart devices to induce vulnerability among older adults [86,87]. This result suggests that nurses and nursing scientists should consider older adults' self-efficacy for information-seeking behavior.

Limitations

The Korean version of PROMIS self-efficacy for managing symptoms can be used to enhance healthcare providers' understanding of patients with chronic diseases and to individualize care plans according to a person's self-efficacy. In addition, it has become possible to benchmark the self-efficacy of chronic diseases on a global level. However, this study has some limitations. First, the study was conducted in a single tertiary hospital and recruited patients with type 2 DM. Therefore, its application to patients with other chronic diseases may be limited. Since the item bank is intended for patients with chronic diseases in general, it is suggested that future studies expand to include other chronic diseases. Second, we evaluated convergent validity using self-care instruments that are frequently used in patients with DM, as the self-efficacy instrument for symptom management can rarely be found; thus, consideration needs to be given to the interpretation of the convergent validity results of this study. Finally, the data had a ceiling effect and the probability of multi-dimensionality. The statistical results indicated that the ceiling effect affected the outcome. In future studies, the inclusion of various patient groups or situations is required to evaluate the psychometric properties of self-efficacy while considering the ceiling effect and multi-dimensionality.

Conclusions

For the Korean version of PROMIS self-efficacy for managing symptoms item bank, the IRT model for psychometric testing was used. The results indicated decent reliability and validity of the measurement. Increasing self-efficacy for managing symptoms in patients with chronic diseases can play a significant role in improving the capability of maintaining their health. Thus, this instrument can facilitate healthcare providers' evaluation of the degree of self-efficacy required to manage symptoms among patients as well as develop educational tools and interventions for their effective management.

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Conflict of interest

The authors declare no conflicts of interest.

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Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted from the Institutional Review Board of Severance Hospital (4-2019-0257) prior to the translation and survey. The purpose and process of this study were explained by the researchers to the participants. The study participants were guaranteed confidentiality and voluntary participation and provided their written informed consent.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

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