Explanatory Factor Analysis of the DM

Exploratory Factor Analysis of the Diabetes Self-Efficacy Scale Among Type 2 Diabetes Mellitus in Thailand

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The aims of this study were to test the construct validity of the Diabetes Management Self-Efficacy Scale (DMSES) among Thai patients with Type 2 Diabetes Mellitus. This methodological study consisted of two stages: (1) Search for existing literature regarding (DMSES) in English to be translated into Thai and further examined for face validity; and (2) explore the factor structure of the resultant instrument and examine its reliability. A self-administered questionnaire was used to collect the data in Thai T2DM patients in February 2016. The finding showed that the Thai Diabetes Management Self-Efficacy scale (T-DMSES) contained four domains with 20 items on self-efficacy: (1) Diet; (2) Monitor; (3) Physical; and (4) Regimen. The scales based on all retained items showed a high degree of internal consistency (Cronbach's $\alpha = 0.89$). The conclusions of this study revealed that the T-DMSES contributed to good construct validity. The said questionnaire could be utilized to explore self-efficacy in Thai T2DM patients, as well as being able to develop and evaluate suitable educational interventions to enhance self-efficacy. Next study should emphasis on further validating the T-DMSES, including assessing construct and criterion-based validity, or examining the psychometric properties by utilizing the Confirmatory Factor Analysis.

Keywords: Diabetes Self-Efficacy Scale, Exploratory Factor Analysis, Type 2 Diabetes Mellitus.

1. INTRODUCTION

Diabetes is considered one of key global public health issues. The estimated number of people with diabetes worldwide was 285 million cases in 2010 and is projected to reach 439 million cases in 2030, the majority of which (69%) are found in developing countries.[1] The number of patients with diabetes in Asia was estimated at 113 million cases in 2010 and will reach 180 million cases in 2030.[2] In a low and middle-income country like Thailand, diabetes represents one of the leading causes of morbidity and mortality.[3] Currently, there are 3.2 million patients with diabetes in Thailand, and this is estimated to rise by 1.1 million patients in 2035.[4]

Diabetes mellitus type 2 (T2DM) is a disease where patients self-care can substantially reduce the risk, or delay the onset, of T2DM complication. The following tasks can substantially make the improvement of diabetes: Taking medications as prescribed; monitoring diet and blood glucose levels; performing physical activities, and caring for feet.[5] All of these tasks come as a package after being diagnosed with diabetes. Such activities needed to be incorporated into daily living and created as behaviors so that patients could control the disease and slow progression and reduce complications.[6] The process as mentioned above is defined as Diabetes Self-Management (DSM).

The Diabetes Self-Management (DSM) provides support for informed decision-making, self-care behaviors, problem-solving, and active collaboration with the health care team, resulting in improved clinical outcomes, health status, and quality of life.[7] The management relies on the long-term cooperation of patients in obtaining regular medical care and adhering to treatment plans.[8–10]

Self-efficacy is referred to as an individual's perceptions or beliefs in their capabilities to carry out certain activities.[11] It is influential to their thinking, feeling, motivation, and behaviors. The person, whose high self-efficacy chooses to perform more challenging tasks, they set higher goals for themselves and adhere to the goals. To take action, individuals who have high self-efficacy exert more effort with more persistence than those who have low self-efficacy. In a case of setbacks, they achieve quicker recovery and continue the commitment to achieving their goals. This efficacious outlook contributes to personal accomplishments, stress reduction, as well as mitigates vulnerability to depression.[12]

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The Diabetes Management Self-Efficacy Scale (DMSES) was originally developed for use in western populations and assesses the confidence of diabetes patients in their ability to manage their diet, blood sugar, and physical exercise.[13] This instrument is primarily utilized to measure self-efficacy. From the past to present, the tool has been widely recognized, adapted, and translated to be correctly used in several areas with the different culture, namely, Netherlands,[13] the United Kingdom,[14] Australia,[9] Turkey,[15] Taiwan,[16] and Korea.[13] However, all related researchers provided different findings possibly because of the various characteristics in each area and sample size. As a result, the original version of the instrument is varied from those in other areas as evidenced by a different number of factors to be generated.[15, 16] Although reported as validated, the methodological approaches used in the validation studies were often valued inappropriately. An instrument developed and validated on Western may not be assumed to be valid in Asian populations. Therefore, to apply the instrument to patients with T2DM in Thailand, it is quite necessary to confirm whether it is proper to use the instrument in Thailand. Moreover, based on the literature review, it was found that the development of DMSE instrument has not been validated. The diabetes management self-efficacy scale (DMSES) among Thai population is seen as an important initial step to achieve the goal of preventive services for patients with T2DM. Therefore, the objective of this study is of test reliability and validity of the Thai Diabetes Management Self-Efficacy scale for measurement in Thailand's context.

2. MATERIALS AND METHOD

This methodological study consisted of two stages:
(1) Search for existing literature regarding Diabetes Management Self-Efficacy Scale (DMSES) in English to be translated into Thai and further examined for face validity; and
(2) Explore the factor structure of the resultant instrument and examine its reliability.

Phase 1. Instrument translation and face validity

The Diabetes Management Self-Efficacy Scale (DMSES) was originally a self-administered scale containing 20 items distributed across four factors, each of which had a 5-point scale.[13] The DMSES items were translated from English into Thai by a forward and backward translation technique. A forward and backward translation technique was performed by two forward and two different backward native bilinguals.[17] Every translator was not accustomed to the content and had no clinical background. The two bilingual translators, whose native language was Thai, independently proceeded with the forward translation from the original version, and then finalized the most accurate and comprehensible terms by consensus. After that, a bilingual translator, who had not been exposed to the original version and the concepts being examined in the questionnaire, translated the items back to English. After the last two bilingual translators had completed back-translation into the English version, two native English translators compared between the English back-translated version and the original English version. Any evident discrepancies between the two translated versions were modified. Then, the back-translation process was carried on until the examiner was satisfied with the language equivalency. The field test for the Thai Diabetes Management Self-Efficacy Scale (T-DMSES) was conducted in 20 T2DM patients to assess the translation

quality and the practicality of the test administration. Respondents were asked to read or listen to each item to ensure their understanding of each item.

Phase 2. Evaluating the psychometric properties of the T-DMSES

1. *Sample and study design*

The study was a cross-sectional study design aiming to test the reliability and validity of the T-DMSES in Thai T2DM patients. 700 T2DM patients were living in both rural and urban areas from The Central and Northeastern Thailand. The T2DM samples were recruited from outpatient diabetes clinics of both community hospitals and University hospitals in KhonKaen province and Bangkok, Thailand. The development of stratification was based on locality, while the determination of sample size was of this study based on factor analysis to establish construct validity: $100 =$ fair, $200 =$ good, $500 =$ very good, and $>1000 =$ excellent.[18] The questionnaire was administered in February–June 2016 to T2DM outpatients aged ≥ 20 years old who were diagnosed with T2DM for more than three years, able to read or understand Thai language and willing to participate in the study. The authorized person of each hospital gave permission to collect the data, and all participants provided informed consent. Then, the data of the participants were collected until the data collection was completed using the participants' self-report. The study protocol was approved by the ethics committee of KhonKaen University (HE581479), Institutional Review Board at Faculty of Medicine, Chulalongkorn University (IRB035/59), and Bangkok Metropolitan Administration Ethics Committee for Human Research (U005q/59).

2. *Demographic and clinical characteristic of DMSES*

The original Version of the Diabetes Management Self-Efficacy Scale (DMSES) was a self-administered scale composed of 20 items designed to investigate behaviors in terms of four factors as follows:

 (1) specific nutrition and weight, with a subscale of five items designed to determine the stick and adjust to diet when away from home, stick to diet on vacation and party, control weight;

 (2) general nutrition and medical treatment, with a subscale of nine items designed to determine the choose and variation in nutrition, stick to diet most of the time, adjust diet when ill and stress check feet, consult physician for diabetes control, used of medication;

 (3) physical exercise, with a subscale of three items designed to determine the extra and take care of training on physician's advice; and

 (4) blood sugar, with a subscale of three items designed to determine the remedy low and high and self-control blood sugar.

The items were scored on a 5-point Likert-type scale, with higher scores indicating higher self-efficacy. From the past to present, the instrument has been widely recognized, adapted, and translated to be properly used in several areas with a different culture.[9, 13, 15, 16]

3. *Statistical analysis*

Demographic data of the participants in this study were summarized using descriptive statistics. Exploratory factor analysis (EFA) was a method to confirm the construct validity of instrument model to seek a single or set of predefined constructs. EFA

Table I. Patient characteristics.

Characteristics ($n = 700$)	n (%)
Parts of Hospital	
Phuphaman Hospital	60 (8.57)
Srinagarind Hospital	78 (11.14)
Wechkaroonrasm Hospital	242 (34.57)
Chulalongkorn Hospital	320 (45.71)
Gender	
Male	208 (29.71)
Female	492 (70.29)
Age (Years)	
Mean (SD)	65.16 (10.94)
Range	26–95
Marital Status	
Single	57 (8.14)
Married	465 (66.43)
Divorce	165 (23.57)
Separate	13 (1.86)
Education	
No formal education	47 (6.71)
Elementary school	381 (54.43)
High school	146 (20.86)
Bachelor degree	99 (14.14)
Master degree	25 (3.57)
Higher degree	2 (0.29)
Religion	
Buddhism	543 (77.57)
Islam	152 (21.71)
Christianity	5 (0.71)
Monthly income	
<4,999 baht (Less than 143 USD)	318 (45.43)
5,000–9,999 baht (143 to 287 USD)	95 (13.56)
10,000–14,999 baht (287 to 413 USD)	86 (12.29)
15,000–19,999 baht (413 to 575 USD)	48 (6.86)
20,000–24,999 baht (575 to 718 USD)	48 (6.86)
>25,000 baht (more than 718 USD)	105 (15.00)
BMI	
<18.5	20 (2.86)
18.5–24.9	279 (39.86)
25–29.9	219 (31.29)
≥30	182 (26)
(Mean = 27.08; SD = 6.32)	
Duration of diabetes	
≤5 years	85 (12.14)
>5 years	615 (87.86)
(Mean = 13.53; SD = 8.34)	
Family history of DM	
Yes	370 (52.86)
No	330 (47.14)
Co-morbidity	
Hyperlipidemia	605 (86.43)
Hypertension	603 (86.14)
Heart disease	38 (5.43)
Renal disease	188 (26.86)
Treatment of DM	
No drug	14 (2)
Oral hyperglycemic agent (OHA)	408 (58.29)
Insulin sensitizer	94 (13.43)
Both OHA and insulin sensitivity	184 (26.29)
Smoking	
No	589 (84.14)
Previously	88 (12.57)
Yes	23 (3.29)
Alcohol	
No	569 (81.29)
Previously	89 (12.71)
Yes	42 (6)
Hba1c	
≤7%	317 (45.29)
>7%	383 (54.71)
(Mean = 7.58; SD = 1.70)	

was used to initially determine the number of latent factors or the pattern of correlations between the common factors and the indicators. Parallel analysis based on Principal Components Analysis was used to determine the nature of the underlying factors. An Oblique (Promax) model was adopted after principal axis factoring models were compared with orthogonal (Varimax) and oblique rotations. Eigenvalues greater than 1 and factor loading cut-off of less than 0.2 were used to acquire the best fitting structure and the accurate number of factors. The R statistics package by v 2.3.0; R CoreTeam, 2015 was used to conduct all analyses, and the R library lavaan was utilized to proceed with the complete factor analysis.[19] Cronbach's alpha was used to evaluate the internal consistency reliability of the overall instrument and the individual subscales. Acceptable reliability for the scale and all subscales was designated to be $\alpha > 0.7$.[20]

3. RESULTS AND DISCUSSION

3.1. Demographic Characteristics of Participants in a Validation Study

There were totally 700 T2DM patients completing the questionnaire (Response rate of 94.3%), with age ranging from 26 to 95 years old (Mean = 65.16, SD = 10.94). The research participants consisted of 29.71% males and 70.29% females. They had been diagnosed with diabetes for 13.53 years on average (SD = 8.34). Other demographic characteristics of the participants were presented in Table I.

3.2. Exploratory Factor Analysis (EFA)

According to the exploratory factor analysis in 700 patients, a parallel group study was conducted, and four-factor structure was deemed appropriate (Fig. 1). The KMO was 0.88 and Bartlett's sphericity test was significant ($\chi^2 = 8576.884$, df = 190, $p < 0.001$) indicating reasonable adequacy of the data for factor analysis. The measurement model for Thai diabetes management self-efficacy scale (T-DMSES) and 20 items was conducted as shown in Figure 2. Nevertheless, the authors decided to retain two of the 20 lower loading items since their inclusion was quite strongly supported by the literature. The principal axis factoring with an oblique rotation was subsequently utilized to explore the factor structure, and the resultant loadings are giving in Table II.

3.3. Internal Consistency

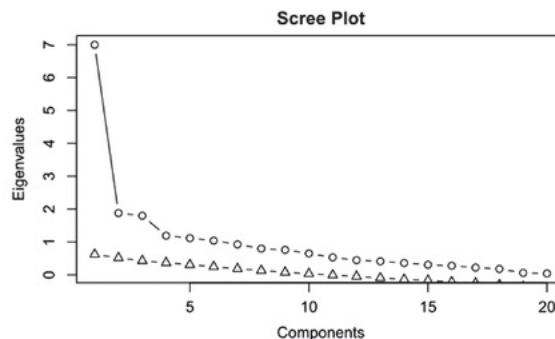Based on the four factor model, the reliability of the T-DMSES was evaluated for internal consistency (Cronbach's

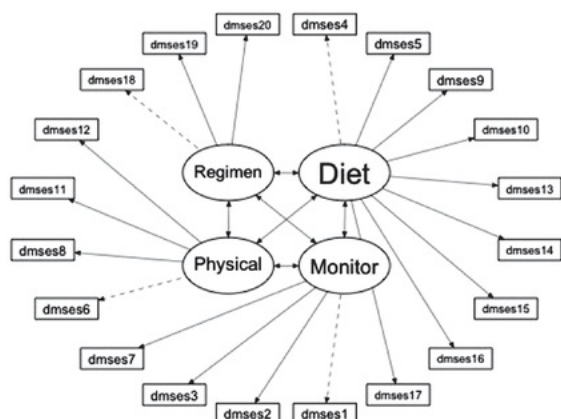**Fig. 1.** Scree plot for determination of number of factors.

Fig. 2. Measurement model for Thai diabetes management self-efficacy scale (T-DMSES).

alpha). The alpha value of 0.89 indicates sufficiently high reliability to provide confidence in interpreting the score.

4. DISCUSSION

To the best of the authors' knowledge, this is the first time that a version of the DMSES has been tested for content validity in Thai T2DM patients. Our instrument provided strong internal consistency reliability. Moreover, it was found that most of the items

strongly aligned with their hypothesized constructs, and enabled researchers and practitioners to gain a better understanding of self-efficacy for seeking interventions. Based on the findings of our study, the T-DMSES revealed that relevant underlying domains for the evaluation of self-efficacy included Diet, Monitor, Physical, and Regimen. Some domains of the T-DMSES were consistent with those identified in previous studies.[16] To conduct the exploratory factor analysis, the authors chose the method of principal axis factoring with oblique rotation to extract factors. The results of such analysis suggested that there were 2 items from an original version of measurement with factor loading <0.2, but they were likely to be associated with self-efficacy in Thai T2DM patients. Therefore, we decided to force two of these 20 items into the model, and see if they should still be excluded in a subsequent confirmatory factor analysis. In particular, blood glucose levels could be checked by myself if necessary, as well as being able to increase blood glucose levels when glucose levels in my blood are too low. Our research had some limitations. First, we considered recruiting T2DM patients from only the Central and Northeastern part of Thailand. The representativeness of this sample for all Thai T2DM patients was not possible. Second, regarding the validation process, T-DMSES had not yet undergone a construct or criterion-based validation at this stage. Even now, there was no evidence that this instrument could either discriminate between T2DM patients who achieved blood sugar levels and those who could not achieve blood sugar levels, or be used to evaluate the efficiency of a program to enhance self-management (predictive validity). Nonetheless, this study also had some major strength. First, our validation of T-DMSES is the most comprehensive

Table II. Factor loading of the T-DMSES from principal axis factoring.

Factors	Items	Diet	Monitor	Physical	Regimen
Diet (9 item)					
dmses4	I can choose to eat good and healthy foods that are beneficial to my health	0.77	–	–	–
dmses5	I can choose to eat various foods to maintain a healthy diet plan	0.79	–	–	–
dmses9	I can maintain a healthy diet plan in the event that I get sick	0.26	–	–	–
dmses10	I can follow a healthy diet plan regularly	0.70	–	–	–
dmses13	I can follow a healthy diet plan even when I am not at home	0.88	–	–	–
dmses14	I can choose from various foods to maintain a healthy diet plan when I am not at home	0.95	–	–	–
dmses15	I can follow a healthy diet plan during festivals, traditions, or rituals	0.93	–	–	–
dmses16	I can choose to eat various foods to maintain a healthy diet plan when I eat foods at parties	0.94	–	–	–
dmses17	I can maintain a healthy diet plan when I am feeling stressed or worried	0.31	–	–	–
Monitor (4 Items)					
dmses1	I can check blood glucose levels by myself if necessary	–	*	–	–
dmses2	I can reduce blood glucose levels when glucose levels in my blood are too high (for example, changing the kinds of foods I eat).	–	0.36	–	–
dmses3	I can increase blood glucose levels when glucose levels in my blood are too low (for example, changing the kinds of foods I eat)	–	*	–	–
dmses7	I can attend to my feet (for example, cutting toe nails and taking care of myself not causing wounds).	–	0.21	–	–
Physical (4 Items)					
dmses6	I can control my body weight and maintain appropriate weight ranges	–	–	0.28	–
dmses8	I can exercise and perform sufficient physical activity (for example, walking, aerobic dancing, muscle exercise, etc.)	–	–	0.67	–
dmses11	I can increase the amount that I exercise if a doctor advises me to do so	–	–	0.88	–
dmses12	In the case that I exercise more, I can modify my healthy diet plan	–	–	0.82	–
Regimen (3 Items)					
dmses18	I can schedule an appointment to see a doctor four times a year to check my diabetes	–	–	–	0.43
dmses19	I can take medicines as prescribed by a doctor	–	–	–	0.89
dmses20	I can keep taking medicines continuously when I am sick	–	–	–	0.70

Note: * Low loading items forced into model.

evaluation of psychometric properties of the DMSES instrument ever conducted in any population. Our study was multi-center and captured the full spectrum of healthcare available in Thailand. In contrast, all previous studies attempting to validate DMSES have used samples of between 88 to 440 patients invariably collected from a single site. Our study applied an appropriate exploratory factor analysis, i.e., principal axis factoring, to identifying the domains underlying the T-DMSES, and we planned to conduct Confirmatory Factor Analysis and criterion-based validation in our next study. On the contrary, the most commonly used instrument for evaluating diabetes management self-efficacy, DMSES,[13] was structured in such a way as to cause difficulties in full psychometric validation.

5. CONCLUSION

The T-DMSES contributed to good psychometric regarding construct validity and internal consistency reliability, suggesting its utility in evaluating self-efficacy in Thai T2DM patients. In the future, T-DMSES would be likely to provide valuable insights into the epidemiology of diabetes management self-efficacy, and may also be used to assess interventions to reduce ineffective self-care in T2DM patients. In turn, this would potentially reduce the incidence and mortality of patients with type 2 diabetes mellitus complications.

Conflict of Interests

The authors declare that there is no conflict of interests in publishing this paper.

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