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Patient characteristics

Pathways of empowerment perceptions, health literacy, self-efficacy, and self-care behaviors to glycemic control in patients with type 2 diabetes mellitus

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ABSTRACT

Objective: To validate a hypothesized model exploring the influencing pathways of empowerment perceptions, health literacy, self-efficacy, and self-care behaviors to glycosylated hemoglobin (HbA1c) levels in patients with type 2 diabetes (T2DM).
Methods: Overall, 295 patients with T2DM were recruited from five endocrine clinics in Taiwan through convenience sampling. Data regarding personal characteristics, empowerment perceptions, health literacy, self-efficacy, self-care behaviors, and HbA1c levels were collected. A structural equation modeling was used to validate the hypothesized model.
Results: Significant direct pathways were determined from empowerment perceptions to health literacy, from health literacy to self-efficacy, from self-efficacy to self-care behaviors, and from self-care behaviors to HbA1c levels.
Conclusions: The empowerment perceptions and health literacy relatively influenced self-efficacy and self-care behaviors. Self-efficacy and self-care behaviors relatively influenced glycemic control in patients with T2DM.
Practice implications: Modifying self-care behaviors have been demonstrated to be the most essential for improving glycemic control. To improve self-care behaviors, healthcare providers should target improving self-efficacy, and enhancing health literacy can be considered to be a potential strategy for improving self-efficacy. To enhance health literacy, healthcare providers could use an empowerment approach rather than an authoritative approach that emphasizes patient compliance in managing patients with T2DM.

1. Introduction

Diabetes has become an epidemic in many countries [1]. Approximately 347 million people are affected by diabetes worldwide [2]. Diabetes, which is estimated to become the seventh leading cause of death by 2030, represents one of the primary non-communicable diseases that affect public health [3]. In Taiwan, the prevalence of diabetes is 9.5%, of which 98.5% is type 2 diabetes (T2DM). Approximately 1.6 million people are affected by T2DM; furthermore, diabetes was the fourth leading cause of death in 2013 [4]. T2DM is an urgent public health issue in Taiwan. Poor glycemic control with glycosylated hemoglobin (HbA1c) levels >7% increases the risk of microvascular complications and cardiovascular disease in patients with T2DM [5]. Understanding the influencing factors and pathways to HbA1c levels is crucial in alleviating the negative effects of T2DM on public health in Taiwan.

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Although personal characteristics, such as age, gender, and educational levels, have been observed to affect the HbA1c levels [5], they cannot be modified. Several amendable psychosocial factors, such as self-care behaviors and self-efficacy, are commonly observed to affect the HbA1c levels. Self-care behaviors are a set of actions that people adopt to improve their health [6]. Adopting effective self-care behaviors is essential in maintaining optimal HbA1c levels for patients with T2DM. Previous studies conducted in China and the US have reported that self-care behaviors directly influenced the HbA1c levels in patients with T2DM [7–9]. Self-efficacy is the strength of a person's belief in his or her ability to complete tasks and is the antecedent of behaviors [10]. Self-efficacy has been found to directly influence self-care behaviors in Chinese and American patients with T2DM [7,9,11] and has also been found to indirectly affect the HbA1c levels through the mediation of self-care behaviors in Chinese patients with T2DM [7].

Health literacy may affect self-care behaviors. Health literacy is an individual's capacity to obtain, process, and understand basic health information and services required to make appropriate health decisions and act accordingly [12]. Health literacy comprises functional, communicative, and critical literacy, which have ascending order of difficulty [13]. Functional literacy refers to the reading and writing skills; communicative literacy refers to the ability to extract meaning from different sources of information and share the information; and critical literacy pertains to the ability to analyze information critically before applying it in the decision-making process. Health literacy may affect self-care behaviors and further affect the HbA1c levels. Health literacy is recognized to positively correlate with self-care behaviors and negatively correlate with the HbA1c levels in American patients with T2DM [14,15].

Understanding the mechanism linking health literacy and self-care behaviors could provide useful knowledge for intervention. According to the framework of health literacy and health outcomes proposed by Paasche-Orlow and Wolf [16], self-efficacy is supposed to link health literacy and self-care behaviors. The patients with higher health literacy may have more confidence in their ability and, finally, may positively influence self-care behaviors. Several earlier studies that conducted regression analyses suggested that health literacy might influence self-care behaviors through the mediation of self-efficacy in American patients with T2DM [17,18]. Nevertheless, the findings of a systematic review did not support this suggestion [19]. The inconsistent conclusions may be attributed to the fact that the majority of studies focused on measuring functional health literacy, which may indicate that reading and writing skills are insufficient to influence self-efficacy. Assessing health literacy beyond functional literacy to communicative and critical literacy may help clarify whether health literacy influences self-care behaviors through mediation of self-efficacy in patients with T2DM.

Identifying amendable influencing factors is helpful for modifying health literacy. Age and educational attainment are well-known to influence health literacy [20,21]. Communicating patterns between healthcare providers and patients are supposed to affect patients' health literacy [22]. Previous studies have indicated that unbalanced power relations between healthcare providers and patients negatively influenced the health literacy of patients [23]. Furthermore, increasing self-awareness can improve the patients' critical health literacy [13]. The empowerment approach is a process that assists patients to think critically and take control of their lives [24], enables the healthcare providers to shift power to patients, makes patients aware of their problems, and allows patients to make their own decisions. The empowerment approach may influence health literacy. The empowerment approach has been proven to improve self-efficacy, self-care behaviors, and glycemic control in Taiwanese patients with T2DM [25]. The empowerment approach may influence health literacy and further influence health outcomes in patients with T2DM. Accordingly, the empowerment perceptions, the perceived degree of empowerment approach provided by healthcare providers, may directly influence health literacy as well as self-efficacy, self-care behaviors, and glycemic control in patients with T2DM. However, few studies have addressed this hypothesis.

Understanding the influencing pathways of empowerment perceptions, health literacy, self-efficacy, and self-care behaviors to HbA1c levels can assist healthcare providers develop evidence-based interventions in patients with T2DM. The structural equation modeling (SEM) is a multivariate statistical analysis technique that combines factor analysis and multiple regression analysis. The SEM considers the measurement error and determines the fit between a hypothesized theoretical model and the sample data. Therefore, the SEM is useful for examining the

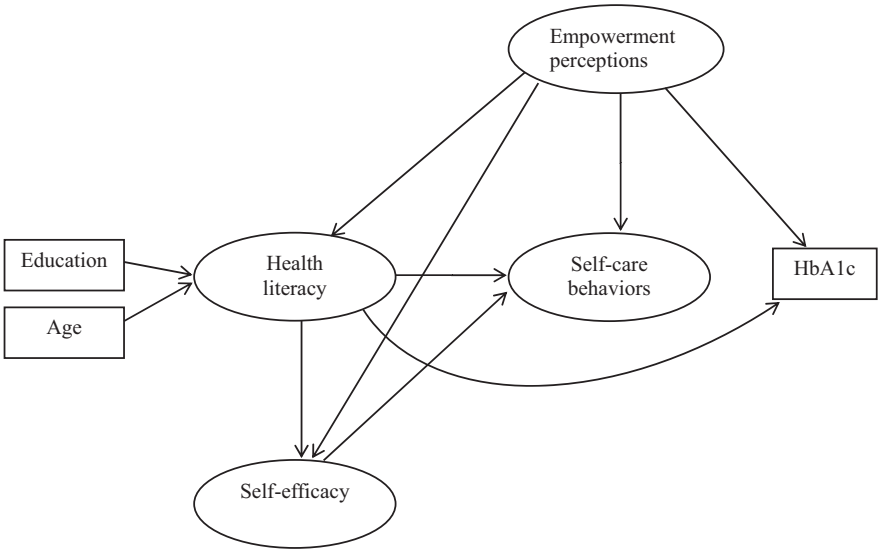

Fig. 1. Hypothesized preliminary model depicting the pathways from latent constructs of empowerment perceptions, health literacy, self-efficacy, and self-care behaviors to HbA1c.

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structural relationship between the measured variables and the latent constructs, and the path relationships among the latent constructs [26]. Several prior studies have applied the SEM to examine the influencing pathways of similar psychosocial factors to glycemic control in American and Chinese populations [7,11,27,28]. Nevertheless, to the best of our knowledge, no studies have simultaneously examined the influencing pathways of empowerment perceptions, health literacy, self-efficacy, and self-care behaviors to HbA1c levels in one model. Based on the literature reviews mentioned above, we hypothesized a preliminary model that will depicting the pathways from empowerment perceptions, health literacy, self-efficacy, and self-care behaviors to HbA1c levels in patients with T2DM (Fig. 1). The purpose of the present study was to validate the hypothesized model using empirical data and the SEM analysis.

2. Methods

2.1. Sampling and data collection procedure

A cross-sectional design was employed in this study. Based on the effect size of the bivariate correlation and power, α values were 0.2, 0.80, and 0.05, respectively, and 197 participants were required. However, a sample size of at least 200 was necessary for testing a hypothesized model [26]. Therefore, assuming an 80% response rate, at least 240 participants were required to be recruited for the present study.

The patients with T2DM were selected through a convenience sampling from the endocrine outpatient clinics of a medical center and four local hospitals in southern Taiwan. The inclusion criteria were as follows: diagnosis of T2DM for >6 months; age between 20 and 80 years (>80 years may have difficulty reading; low prevalence of T2DM in age <20 years); and ability to read and communicate. The physicians referred the eligible participants who were visiting the clinics on weekdays to a trained research assistant, who explained the purpose of the study and administered anonymous self-reported questionnaires to the participants who had provided their informed consent. In a private room at the clinic, the participants completed the questionnaires either independently or with the help of a research assistant. Among the 325 eligible participants referred by physicians, 295 participants completed the questionnaires, with a response rate of 90.8%. The data were collected from March 2014 to July 2014.

2.2. Measures

The medical records were reviewed to document the most recent HbA1c values for all of the participants who submitted blood samples after they had completed the questionnaires. The anonymous self-reported questionnaires were used to collect personal characteristics and assess psychosocial factors (empowerment perceptions, health literacy, self-efficacy, and self-care behaviors). The self-reported questionnaires included the sections indicated below.

2.2.1. Personal characteristics

The patients' data regarding age, sex, level of education, occupational status, and duration of diabetes were collected. The patients' occupational status was converted to socio-economic status [29].

2.2.2. Empowerment perceptions scale

A 15-item Chinese version diabetes empowerment process scale [30] was used to assess the participants' perceived degree of empowerment approach provided by the healthcare providers. The example item was as follows: "My healthcare professionals treated me as an equal and as a friend rather than as a client." Each item was rated using a 5-point scale, from "strongly disagree" (0 points) to "strongly agree" (4 points). In conducting the SEM analysis, the validity of measurement was a subject of concern. The exploratory factor analysis (EFA) was performed to preliminarily examine the construct validity of the empowerment perceptions scale. The items with factor loading <0.4 were excluded because they accounted for little variance [31]. After EFA, two items were deleted because of factor loading <0.4. One factor that accounted for 69.64% of the total variance in empowerment perceptions was obtained. Possible scores ranged between 0 and 52, with higher scores indicating the participants' higher empowerment perceptions. Cronbach's α was 0.96 for the total scale in this study.

2.2.3. Diabetes health literacy scale

A 14-item Japanese version diabetes health literacy scale [32], including subscales of functional, communicative, and critical health literacy, was used to assess the health literacy of the participants. The scale has adequate validity and reliability in Japanese patients with T2DM [32,33]. The scale was translated and back-translated by the research team to ensure the semantic equivalence between the original and the translated scales. The example item was as follows: "Since being diagnosed with diabetes, you have considered the credibility of the information." Each item was rated using a 4-point scale, ranging from "never" (1 point) to "often" (4 points). The items of functional health literacy were reversely scored. After EFA, the 14 items were all retained. The items pertaining to communicative health literacy and critical health literacy were loaded on one factor. Finally, two factors, functional (five items) and communicative and critical health literacy (nine items), which accounted for 69.84% of the total variance in health literacy, were produced. Possible scores ranged between 14 and 56, with higher scores indicating higher health literacy. Cronbach's α was 0.89 for the total scale in this study.

2.2.4. Diabetes self-efficacy scale

A 14-item Chinese version self-efficacy for diabetes management scale [34] was used to evaluate the patients' confidence in performing exercise and diet modification, medication adherence, blood sugar monitoring, hypo- and hyperglycemia management, and foot care. The example item was as follows: "My confidence in maintaining the dose of my medication is —." Each item was rated, using a 5-point scale ranging from "extremely unconfident" (0 points) to "80% to 100% confident" (4 points). After EFA, the items pertaining to exercise and diet were grouped into one factor named "diet and exercise" (eight items). The items pertaining to adherence to medication were grouped into one factor named "medication" (two items). The items pertaining to hypo- and hyperglycemia management and foot care were grouped into one factor named "adversity prevention" (four items). These three factors accounted for 58.65% of the total variance in self-efficacy. Possible scores ranged between 0 and 56, with higher scores indicating higher self-efficacy for diabetes management. Cronbach's α was 0.85 for the total scale in this study.

2.2.5. Diabetes self-care behaviors scale

A 17-item Chinese version diabetes self-care scale [8] was used to evaluate the participants' degree of performing diabetes self-care activities. The scale included items pertaining to exercise, diet management, medication adherence, blood sugar monitoring, hypo- and hyperglycemia management, and foot care. The example item was as follows: "I follow the rules of diet control when eating" Each item was rated using a 5-point scale ranging from "never" (0 points) to "always" (4 points). After EFA, the items pertaining to medications (three items), diet (three items), exercise (three

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items), and blood sugar monitoring (four items) were individually grouped into factors of medications, exercise, diet, and blood sugar monitoring, respectively. The items pertaining to hypo- and hyperglycemia management and foot care were grouped into a factor named "adversity prevention" (four items). These five factors accounted for 66.01% of the total variance in self-care behaviors. Possible scores ranged between 0 and 68, with higher scores indicating more positive self-care behaviors. Cronbach's α was 0.82 for the total scale in this study.

2.3. Validity and reliability of scales

The content validity of each scale was assessed by an endocrinologist, two nursing professors, a nutritionist, and two diabetes educators. Each expert ranked the relevance of each item from "no relevance; can be deleted" (1 point) to "very relevant" (4 points). No items were deleted. Furthermore, the wordings of several items were revised according to the suggestions of the experts. The content validity index (CVI) for each scale was calculated as the number of items rated 3 points or 4 points (by the experts) divided by the total number of items in that scale. The CVI values ranged from 0.9 to 1.0, indicating that the scales were acceptable for use. The internal consistency was calculated using Cronbach's α based on the data of all of the participants. The EFA was performed to examine the construct validity of each scale. As mentioned above, the reliability and the validity of each scale were acceptable.

2.4. Ethical considerations

The study was approved by the Institutional Review Board of Kaohsiung Medical University, Taiwan. All of the participants were informed that there was no penalty for refusal to participate in the study and that they were allowed to withdraw from the study at any time. All of the participants signed the consent forms before participating in the study.

2.5. Data analysis

SPSS for Windows Version 16.0 (SPSS Inc., Chicago, IL,USA) was used for descriptive, comparative, and bivariate correlation analyses. The SEM was conducted using AMOS Version 17.0.2. The variables of health literacy, self-efficacy, and self-care behaviors were considered as latent constructs. The factors produced by the EFA of each scale were considered as observable variables for each latent construct. The empowerment perceptions and the HbA1c levels were considered as observed variables because they were without sub-factors. A series of SEM analyses was conducted to identify the most parsimonious and best-fit model. A model was considered a good fit if the χ^2/df was <3; the goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and comparative fit index (CFI) were all >0.90; and the root mean square error of approximation (RMSEA) values were approximately 0.06. The Akaike information criterion (AIC) is a fit index that considers both the measure of fit and the model complexity. A lower AIC value indicates a more parsimonious model [35].

A model-generating strategy was applied to find the best-fit model. The hypothesized preliminary model was first tested. If the model did not fit the data well, the model was further modified and tested until the best fitting and the most parsimonious model was finalized. The modification was conducted according to both the statistical and practical significance of the parameters and modification indices suggested by the SEM. An α level of 0.05 was considered to be significant.

3. Results

3.1. Distributions of personal characteristics, psychosocial factors, and associations among them

Table 1 shows the distributions of personal characteristics and their associations with the study psychosocial factors. The HbA1c levels of the participants ranged between 5.9% and 14.1%. Table 2 shows the mean values of the HbA1c levels and the study of

Table 1
Personal characteristics and their associations with the empowerment perceptions, health literacy, self-efficacy, self-care behaviors, and HbA1c (n = 295).

Personal characteristics	Mean (SD)/n (%)	Empowerment perceptions	Health literacy	Self-efficacy	Self-care behaviors	HbA1c
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)						
r values	58.2 (11.8)	−0.10**	−0.19***	0.17**	0.18**	−0.14**
Sex						
Male	169 (57.3)	42.4 (7.2)	44.3(8.5)	40.8(9.4)	46.7 (11.0)	7.5 (1.4)
Female	126 (42.7)	43.3 (7.0)	44.7(9.3)	40.1 (11.0)	42.9 (11.5)	7.4 (1.3)
t values		1.11**	0.37	0.57	2.88*	0.74
Educational level						
Literate/elementary school	70 (23.7)	40.9 (5.6)	40.3 (10.2)	40.4(9.8)	44.0 (12.7)	7.3 (1.3)
Junior school	40 (13.6)	42.0 (8.1)	43.7(8.3)	41.3 (10.4)	47.7(9.7)	7.7 (1.7)
Senior school	94 (31.9)	43.8 (6.7)	45.5(8.8)	38.9 (11.7)	44.3 (12.9)	7.5 (1.4)
College and above	91 (30.8)	43.5 (7.8)	47.0(6.9)	41.6(9.1)	43.6(9.2)	7.3 (1.2)
F values		2.69**	8.64***	1.19	1.29	1.04
Socio-economic status						
Low	187 (67.5)	42.3 (7.1)	43.9(9.2)	41.1(9.9)	45.1 (11.9)	7.3 (1.3)
Middle	68 (24.6)	43.3 (7.0)	45.0(8.3)	38.8 (11.4)	42.8 (10.0)	7.6 (1.5)
High	22 (09.9)	47.0 (6.8)	47.9(7.6)	41.7(9.5)	43.9 (11.0)	7.4 (1.4)
F values		4.24**	2.11	1.50	1.06	1.43
Duration of diabetes (years)						
r values	9.9 (7.2)	−0.04**	−0.14*	0.04	0.09	0.16**

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

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Table 2
Distribution of and correlation among the empowerment perceptions, health literacy, self-efficacy, self-care behaviors, and HbA1c ($n = 295$).

	Mean (SD)	Health literacy	Self-efficacy	Self-care behaviors	HbA1c
Empowerment perceptions	42.8 (7.1)	0.28***	0.30***	0.26***	−0.06
Health literacy	44.5 (8.8)	–	0.28***	0.15*	−0.01
Self-efficacy	40.4 (10.3)		–	0.53***	−0.19***
Self-care behaviors	44.5 (11.4)			–	−0.17**
HbA1c	7.4 (1.4)				–

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

psychosocial factors as well as the associations among them. As shown in Table 2, significantly positive associations were observed among the empowerment perceptions, health literacy, self-efficacy, and self-care behaviors. However, only self-efficacy and self-care behaviors were significantly negatively associated with the HbA1c levels.

3.2. Test of the model

First, the hypothesized preliminary model was tested using the SEM. We did not test the pathways between the variables that were not significantly correlated in the bivariate analysis, such as the pathways from the empowerment perceptions and health literacy to HbA1c. The fit indices were $\chi^2/df = 4.732$, GFI = 0.859, AGFI = 0.794, CFI = 0.655, RMSEA = 0.113, and AIC = 406.702. The results indicated that the hypothesized preliminary model did not fit the data well. Furthermore, the direct pathway coefficients from age to health literacy ($\beta = -0.13$, $p > 0.05$), from health literacy to self-care behaviors ($\beta = 0.13$, $p > 0.05$), from the empowerment perceptions to self-efficacy ($\beta = 0.12$, $p > 0.05$) and to self-care behaviors ($\beta = 0.07$, $p > 0.05$) were not significant.

Because the hypothesized preliminary model did not fit the data well, it had to be modified and tested further. The non-significant pathways found in the hypothesized preliminary model were deleted in the modified mode. The educational level can be collinear with health literacy; this factor can confound the pathway relationships between health literacy and other constructs. Therefore, we excluded the pathway from the educational level to health literacy. We also set the correlations of error variances between self-efficacy of medication and self-care behaviors of medication and between self-efficacy of diet and exercise and self-care behaviors of diet according to the modification indices suggested by the SEM analysis conducted on the hypothesized preliminary model.

As shown in Fig. 2, all of the observed variables significantly loaded on their corresponding latent constructs, supporting the construct validity of each latent construct. Furthermore, the significant direct pathways were found from the empowerment

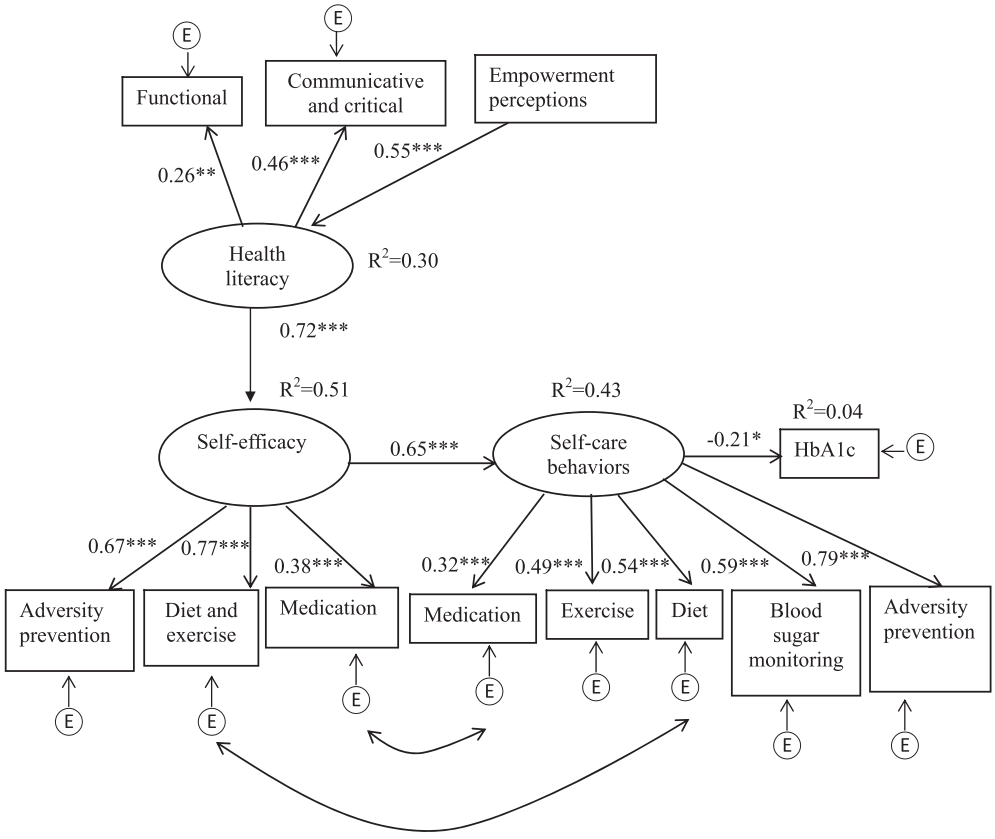

Fig. 2. Final model and standardized pathway coefficients among the empowerment perceptions, health literacy, self-efficacy, self-care behaviors, and HbA1c. E, error variance; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

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perceptions to health literacy, from health literacy to self-efficacy, from self-efficacy to self-care behaviors, and from self-care behaviors to HbA1c. The empowerment perceptions significantly indirectly affected self-efficacy ($\beta_{indirect} = 0.39$, $p < 0.001$) through the mediation of health literacy and indirectly affected self-care behaviors ($\beta_{indirect} = 0.26$, $p < 0.001$) through the mediation of health literacy and self-efficacy. Health literacy significantly indirectly affected self-care behaviors ($\beta_{indirect} = 0.47$, $p < 0.001$) through the mediation of self-efficacy. Self-efficacy significantly indirectly affected HbA1c ($\beta_{indirect} = -0.14$, $p < 0.05$) through the mediation of self-care behaviors. The fit indices were $\chi^2/df = 1.785$, GFI = 0.953, AGFI = 0.962, CFI = 0.936, RMSEA = 0.052, and AIC = 145.253. The AIC of the final model was lower than that of the hypothesized preliminary model. The fit indices indicated that the final model fit the data well and was more parsimonious than the hypothesized preliminary model. Furthermore, the empowerment perceptions accounted for 30% of the total variance in health literacy, and health literacy accounted for 51% of the total variance in self-efficacy. Self-efficacy accounted for 43% of the total variance in self-care behaviors, and self-care behaviors accounted for 4% of the total variance in the HbA1c levels.

4. Discussion and conclusions

4.1. Discussion

The measurements of the latent constructs in this study were valid. The fit indices of the final model were acceptable, and all of the parameters were statistically significant and reasonable. The results supported the correctness of the final model specification. Consistent with the previous findings [7,8,9], self-care behaviors directly negatively influenced the HbA1c values. These findings emphasized that modifying self-care behaviors is essential to improve glycemic control. Self-efficacy directly influenced self-care behaviors and could indirectly influence the HbA1c levels through the mediation of self-care behaviors. Improving self-efficacy is crucial when designing interventions to enhance self-care behaviors and decrease the HbA1c levels for patients with T2DM.

The dimensions of functional, communicative, and critical health literacy were measured in this study. Health literacy directly affected self-efficacy in this study. Furthermore, health literacy accounted for 51% of the total variance in self-efficacy. The functional, communicative, and critical health literacy are all important to influence the self-efficacy of patients with T2DM. However, the factor of communicative and critical health literacy was found to account for more total variance in the construct of health literacy than the factor of functional literacy. The communicative and critical health literacy may be more important than the functional health literacy in influencing self-efficacy. Previous studies also demonstrated similar findings [32,33]. Performance accomplishments are the most important source of enhancing self-efficacy [10]. The patients with high communicative and critical health literacy may more actively apply information to modify situations and achieve successful accomplishments, thereby finally improving self-efficacy. Enhancing the communicative and critical health literacy may be an effective strategy for improving the self-efficacy of patients with T2DM. However, additional experimental studies are required to validate the recommendation. Health literacy indirectly influenced self-care behaviors through the mediation of self-efficacy in this study. The result provided evidence that self-efficacy links the relationships between health literacy and self-care behaviors, which echoes the framework of health literacy and health outcomes [16]. Modifying health literacy might be useful in influencing self-efficacy and self-care behaviors.

The association between health literacy and HbA1c levels has been less frequently examined in Asian populations. In this study, health literacy was not significantly associated with the HbA1c levels, which is consistent with previous studies conducted in the US [36,37]. However, another previous study conducted in the US found that the association between health literacy and the HbA1c levels was significant, but with a small effect size ($r = -0.01$) [28]. The influence of health literacy on the HbA1c levels may be attenuated because of the transmission through self-efficacy and self-care behaviors in this study. The sample size in this study may lack sufficient power to detect the small influence of health literacy on the HbA1c levels. The relationship between health literacy and glycemic control may vary with clinical settings and patient populations [14]. The studies with a large sample size and international comparisons are required to clarify the relationship between health literacy and glycemic control.

To the best of our knowledge, this study is the first to identify that the empowerment perceptions directly affected health literacy in patients with T2DM. The empowerment approach aimed to increase the patient's ability to think critically and make decisions autonomously [24]. It is reasonable that the patients who perceived more empowerment approach provided by healthcare providers exhibited better functional, communicative, and critical health literacy. The empowerment perception indirectly influenced self-efficacy and self-care behaviors through the mediation of health literacy, although it had no effect on the HbA1C levels in this study. This finding adds to the body of knowledge on understanding the role of the empowerment approach in glycemic control. The empowerment approach may be a useful educational strategy for improving health literacy, self-efficacy, and self-care behaviors in patients with T2DM. Mutual participation, raising awareness, providing necessary information, and open communication are crucial strategies of the empowerment approach [30]. Healthcare providers may apply empowerment strategies to educate patients with T2DM. However, future experimental studies are needed to confirm the effect of the empowerment approach on patients with T2DM.

The findings of this study provide a model for depicting the influence of the empowerment perceptions, health literacy, self-efficacy, and self-care behaviors on glycemic control in patients with T2DM. This model can provide useful knowledge for healthcare providers to design theory-based intervention programs for patients with T2DM. However, several limitations must be acknowledged. First, the pathways among the psychosocial factors in this study were based on the data from a cross-sectional study, which provided only information indicating that the model could not be rejected. Additional longitudinal and experimental studies are required to confirm the causal pathways among the psychosocial factors in the final model. Second, the participants were selected using a convenience sampling from five clinics in Taiwan. The participants were required to be able to read, which might exclude older participants. Therefore, the mean age of the participants in this study was younger than that in a previous study (63.7 ± 13.9 years) in Taiwan [38]. Accordingly, the results cannot be generalized to patients with T2DM in Taiwan or other countries. The final model must be validated in other populations in Taiwan and in diverse ethnic groups. Third, the type of treatment and comorbid conditions may influence the HbA1c levels [5]. Additional studies should consider the influences of these variables on the HbA1c levels. Fourth, the measurements in this study were self-reported and, thus, may not be perfect; nevertheless, self-reporting is the most common method for measuring psychosocial variables in primary care research [39]. The potential social desirability bias must be considered, and the results must be cautiously interpreted.

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4.2. Conclusion

Self-care behaviors directly influenced the HbA1c levels in patients with T2DM. Self-efficacy directly influenced self-care behaviors and indirectly influenced the HbA1c levels through the mediation of self-care behaviors. Health literacy directly influenced self-efficacy and indirectly influenced self-care behaviors through the mediation of self-efficacy. The empowerment perceptions directly influenced health literacy and indirectly influenced self-efficacy through the mediation of health literacy. The empowerment perceptions also indirectly influenced self-care behaviors through the mediation of health literacy and self-efficacy. Self-efficacy and self-care behaviors relatively influenced glycemic control. The empowerment perceptions and health literacy relatively influenced self-efficacy and self-care behaviors, although their influences on glycemic control were minimal in the patients with T2DM.

4.3. Practice implications

Healthcare providers can apply the findings of this study to manage patients with T2DM. Because self-care behaviors directly influence the HbA1c levels, modifying self-care behaviors is essential for improving glycemic control in patients with T2DM. To improve self-care behaviors, healthcare providers should target the improvement of self-efficacy, and enhancing health literacy can be considered to be a potential strategy for improving self-efficacy and self-care behaviors. To enhance the health literacy of patients with T2DM, healthcare providers could provide an empowerment approach rather than an authoritative approach that emphasizes patient compliance.

Conflict of interest

The authors declare no conflict of interest.

Author contribution

Ruey-Hsia Wang, designed research, data analysis, wrote the manuscript, and reviewed/edited the manuscript. Yau-Jiunn Lee, collected research data, assisted with writing the manuscript, and reviewed/ edited the manuscript. Shyi-Jang Shin, Kun-Der Lin, and Yu-Li Lee, collected research data, contributed to the discussion, and edited the manuscript. Yi-Hsien Wang, assisted with data analysis and edited the manuscript.

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