A Causal Model of Health Literacy among Thai Older Adults with Uncontrolled Diabetes

Jeraporn Tongdee, Darawan Thapinta, Sirirat Panuthai, Rojanee Chintanawat*

Abstract: Uncontrolled diabetes among older adults leads to acute and chronic complications that threaten health and life. Health literacy is crucial to managing health and making successful behavior changes for optimal diabetes outcomes. However, a clear understanding of multiple factors and their mechanisms to influence health literacy is lacking. This descriptive cross-sectional study aimed to test a Model of Health Literacy among Thai Older Adults with Uncontrolled Diabetes and examined the influencing pathways of cognitive function, diabetes knowledge, provider-patient communication, empowerment perception, social support, Internet use, and social engagement regarding health literacy. The sample consisted of 259 older Thai adults with uncontrolled diabetes. Data were collected using a demographic data form, the European Health Literacy Survey Questionnaire, the Diabetes Knowledge Scale, the Diabetes Empowerment Process Scale, the Provider-patient Communication Scale, the Social Support Questionnaire, the Montreal Cognitive Assessment-Basic Test, the Internet Use Questionnaire, and the Being Actively Engaged with Society Subscale of the Active Ageing Scale for Thai People. Data were analyzed using descriptive statistics and structural equation modeling with AMOS.

The results showed that the model explained 76% of the health literacy variance. Diabetes knowledge and cognitive function directly affected health literacy. Health literacy was indirectly affected by provider-patient communication and empowerment perception through diabetes knowledge, social engagement through cognitive function, and Internet use through cognitive function and diabetes knowledge. Nurses can develop strategies by integrating Internet use and social engagement in empowerment communication programs to improve diabetes knowledge and cognitive function toward higher health literacy in this population.

Keywords: Causal model, Health literacy, Older adults, Structural equation modeling, Uncontrolled diabetes

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Introduction

Diabetes is a serious health issue in the older population worldwide, with about 25% of older adults 65 years of age and older living with diabetes.[1] In Thailand, the prevalence of older adults with diabetes

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has risen dramatically in recent years. According to a national health survey, 16.5% of Thai older adults had diabetes, with a hospitalization rate of 19% and 30% among male and female older adults, respectively.[2] When compared with younger adults, achieving optimal glucose control is more challenging for most older adults with type 2 diabetes. Uncontrolled diabetes is indicated by a glycated haemoglobin (HbA1C) level higher than 7%.[3] Importantly, 76.4% of older adults with type 2 diabetes were uncontrolled.[4] Uncontrolled diabetes can lead to acute and chronic complications that threaten health and endanger life.[1] Uncontrolled diabetes in older adults results from inappropriate health behaviors,[5] which can be improved through health literacy.[6]

Health literacy is a vital indicator of the success of improving behaviors.[6] However, inadequate health literacy is common in older adults with diabetes worldwide, including Thailand, as 67.06% of such adults have inadequate health literacy.[7] Inadequate health literacy among older adults with diabetes was associated with suboptimal diabetes control, life-threatening complications, morbidity and mortality, while adequate health literacy led to improved health behavior, thereby resulting in better health outcomes, including effective glycemic control.[8] Therefore, promoting health literacy is necessary, and this requires an understanding of the influencing factors among uncontrolled diabetes in older adults.

Conceptual Framework and Literature Review

This study's conceptual framework was the Integrated Model of Health Literacy.[9] Health literacy describes individuals' knowledge, motivation, and competence in accessing, understanding, appraising, and applying health information to reach judgments and daily decisions about maintaining or enhancing the quality of life through health care, preventing illnesses, and promoting health.[9] Health literacy includes capabilities of accessing (looking for, finding, and getting health information), understanding (comprehending health information), appraising (interpreting, filtering, judging, and evaluating health information), and applying (interacting with others and utilizing the information for health decisions) health information.[9]

Moreover, the above model illustrates proximal and distal antecedents of health literacy. Proximal factors comprise personal determinants and situational determinants. Personal determinants are individual characteristics affecting health literacy.[9] It is well recognized that aging affects one's cognitive function, which is the capability to perform intellectual tasks and mental processes encompassing the important dimensions of visual perceptions, executive function, language, attention, memory, and orientation.[10] Cognitive function involves mental processing to produce quick and efficient thoughts, understand information, think critically, weigh choices, and make a decision and inferences and has been directly associated with health literacy among older adults with diabetes.[11] Another personal determinant is diabetes knowledge, which refers to understanding diabetes in general or the facts regarding diabetes.[12] Knowledge and understanding of diabetes contribute to learning and confidence in accessing information, understanding, making critical analysis and appraisal, and demonstrating independent action for engagement in self-care, risk prevention, and health promotion. Research has shown a direct relationship between diabetes knowledge and health literacy among older adults with diabetes.[6]

Situational determinants are surrounding conditions of the individuals, which serve as either facilitators or barriers to health literacy.[9] An important situational determinant is the availability of accessible, understandable and reliable health information. Provider-patient communication refers to interpersonal communication to understand and exchange health

information.[13] Critical thinking and social skills are developed while sharing health information with providers, enabling older adults to improve their health literacy. Provider-patient communication positively affected and increased health literacy directly,[14] and indirectly through diabetes knowledge.[15] Furthermore, empowerment perception is another situational determinant through supportive networks facilitating health literacy. It refers to clients' perception of health care providers shifting power to them, making them aware of their problems, and allowing them to decide on their own.[16] This process drives older adults into active learners to effectively negotiate and be self-confident in interactions with medical professionals, resulting in higher health literacy. Empowerment perception affected the health literacy of adults with type 2 diabetes directly and indirectly through diabetes knowledge.[18] Another situational determinant is social support, described as the perceived help available from friends, family, and significant others.[19] Information support allows older adults to use the information for problem-solving. Instrumental support makes access to health services more convenient. Emotional support offers hope to live, while appraisal support enables them to perform self-evaluation, facilitating healthcare service access and improving health literacy. Social support has been associated with health literacy directly and indirectly through diabetes knowledge.[21] Additionally, the Internet is a valuable resource for older adults to interact socially and research health topics. Internet use refers to using an online communication system for health purposes.[22] Internet use provides opportunities to access information, learn, and interact with others, enhancing health literacy. Studies affirmed that more Internet use in health topics led to better health literacy directly, [22, 23] and indirectly through cognitive function [11,24] and diabetes knowledge.[25]

Distal factors are societal and environmental determinants, such as demographic circumstances and cultural and social contexts, which broadly affect health literacy.[9] Social engagement refers to participating in collective activities, which contribute to social capital and social norm reinforcement.[26] Engagement in society offers interaction and social exchange with others, contributing to developing social and cognitive skills that improve health literacy. Social engagement was associated with health literacy directly,[27] and indirectly through internet use[28] and cognitive function.[29]

Existing literature has revealed significant factors affecting health literacy among older adults with diabetes. These factors comprise cognitive function, diabetes knowledge, provider-patient communication, empowerment perception, social support, internet use, and social engagement. Although these factors have been confirmed as influencing the health literacy of older adults in the diabetes context, there is limited research on those with uncontrolled diabetes. Existing knowledge is still unclear and may not apply to those with uncontrolled diabetes. It is unknown how these factors influence the health literacy of older adults with uncontrolled diabetes. For these reasons, there is still a need to verify the integration of numerous factors to fully understand the causal relationship of health literacy. A full understanding of the multiple factors and their pathways leading to health literacy is significant to the development of effective interventions for enhancing health literacy among older adults with uncontrolled diabetes.

Study Aims

The aims of this study were to test the Model of Health Literacy among Thai Older Adults with Uncontrolled Diabetes (MHLTOAUD) and to examine the direct and indirect effects of cognitive function, diabetes knowledge, provider-patient communication, empowerment perception, social support, internet use, and social engagement on health literacy. The hypothesized model is illustrated in **Figure 1**.

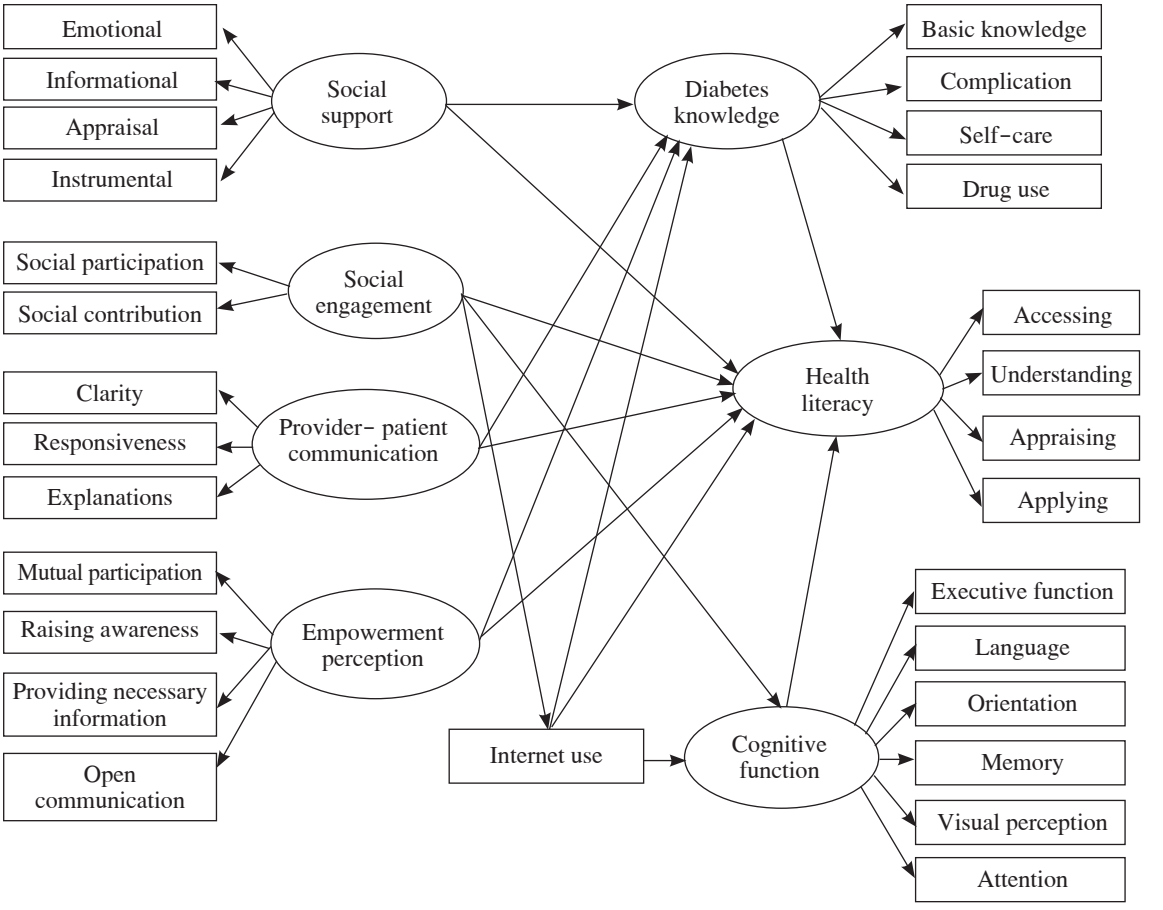

Figure 1. The hypothesized MHLTOAUD

Method

Design: We used a cross-sectional, model-testing design. This study was reported following the STROBE guideline for cross-sectional studies.

Sample and Setting: We used a multi-stage random sampling method to identify 300 older adults with uncontrolled diabetes registered at sub-district health-promoting hospitals in one province in the south of Thailand (**Figure 2**). They were recruited following the inclusion criteria: 1) age 60 years and over; 2) diagnosed with type 2 diabetes and receiving medication treatment for at least one year; 3) ability to understand the Thai language; 4) having records of HbA1C > 7% or fasting blood sugar (FBS) > 130 mg/dl within the past six months;[3] and 5) no cognitive impairment with a score more than 17 as measured by the Montreal Cognitive Assessment-Basic Test (MoCA-B). The sample size was determined based on the model complexity and basic characteristics of the measurement models for SEM testing, requiring a sample size of 150-300 for a model with seven or fewer constructs.[30] For the model in this study, there were seven constructs, with one construct having two observations/indicators. Therefore, the sample size required was 300.

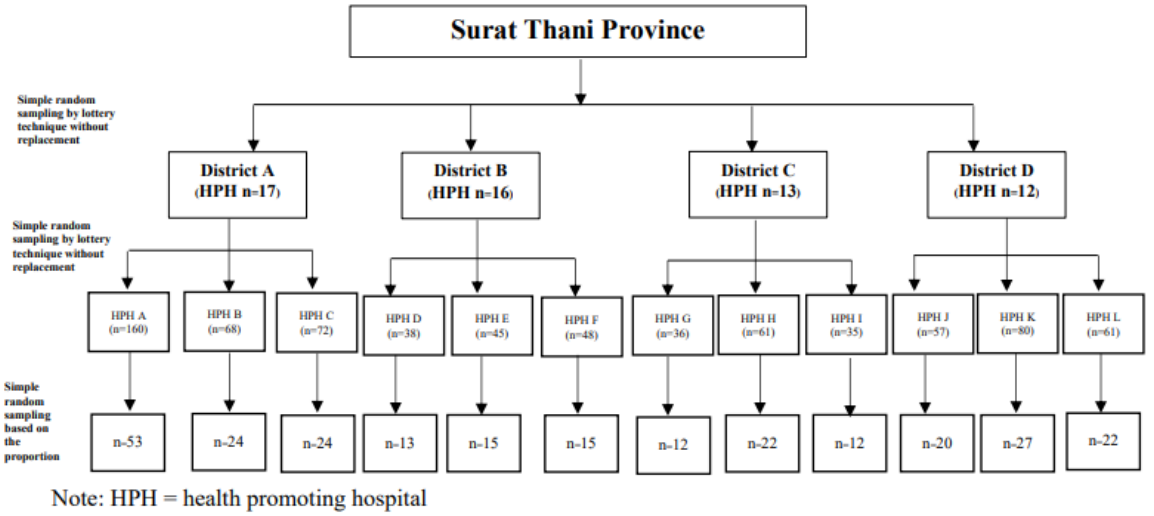

Figure 2. Multi-stage random sampling of this study

Ethical Considerations: Our study obtained approval from the Research Ethics Committee of the Faculty of Nursing, Chiang Mai University (Research ID: 2019-124; Study Code: 2019EXP084), and permission to collect data from the Provincial Public Health Office of the selected province. The study was fully explained to participants, including study objectives, risks and benefits, protection of confidentiality and anonymity, and the right to discontinue involvement without negative consequences. Each participant gave written informed consent. COVID-19 transmission prevention was strictly maintained through masking, social distancing, and alcohol hand rub.

Instruments: Nine instruments were employed in data collection. With permission from the original developers, three instruments, the European Health Literacy Survey Questionnaire, the Diabetes Empowerment Process Scale, and the Internet Use Questionnaire, were translated from English into Thai using the back-translation technique.[31] Six experts validated the content validity of the translated instruments: two nurse educators in geriatric nursing and health literacy, one diabetes educator, one researcher with experience in psychological studies of empowerment, one researcher experienced in Internet use, and one experienced in health communication. The scale-level content validity index (S-CVI) was 0.96, 0.95, and 0.98, respectively. Reliability coefficients from the pretest with ten older adults with uncontrolled diabetes and from the actual study (n = 259), along with examples of the items, are presented in **Table 1.**

Table 1. Cronbach's alpha reliability and examples of items of instruments (n = 259)

Instrument	Reliability		Example of Items
	Pilot Study	Actual Study	
The European Health Literacy Survey Questionnaire	.98[a]	.99[a]	To what extent would you say it is easy to find information about symptoms of illnesses that concern you?
The Diabetes Knowledge Scale	.85[b]	.81[b]	Diabetes can be cured.
The Diabetes Empowerment Process Scale	.94[a]	.98[a]	The doctor/nurse inspired me to take responsibility for my diabetes care.

Table 1. Cronbach's alpha reliability and examples of items of instruments (n = 259) (Cont.)

Instrument	Reliability		Example of Items
	Pilot Study	Actual Study	
The Provider-Patient Communication Scale	.90[a]	.92[a]	Doctor/nurse/pharmacist recommends how to take antidiabetic medications (when, how much, and for how long to take medications).
The Social Support Questionnaire	.93[a]	.97[a]	You receive love and care from people close to you when you are ill.
The Montreal Cognitive Assessment-Basic Test	.92[a]	.93[a]	Name as many fruits as possible in one minute.
The Internet Use Questionnaire	.91[b]	.96[b]	Participating in online support groups such as sharing opinions or asking for health information in Line groups.
The Being Actively Engaged with Society Subscale of the Active Ageing Scale for Thai People	.90[a]	.92[a]	You always participate in activities of the elderly club or your membership club.

Note. [a] Cronbach's alpha, [b] Kuder-Richardson 20

A demographic data form was designed by the primary investigator (PI). It consisted of 11 close-ended items about gender, age, religion, marital status, educational level, personal income, number of family members, time since diagnosis, comorbidity, FBS and/or HbA1C levels, and health information sources.

The European Health Literacy Survey Questionnaire created by Sørensen et al.[32] was adopted to assess health literacy. It comprises 47 items in four subscales: accessing, understanding, appraising, and applying. Items are rated on a 4-point Likert scale from 1 (very difficult) to 4 (very easy) to assess the perceived difficulty of selected health-relevant tasks. All scores are transformed to a standardized metric based on the formula: Index = (mean -1) × 50/3. The possible total score ranges between 0 and 50. The score correlates to four levels: inadequate (0-25), problematic (>25-33), sufficient (>33-42), and excellent (>42-50).[32]

The Diabetes Knowledge Scale developed by Wongwiwatthananukit et al.[33] measures diabetes knowledge. It has 21 items in four subscales: basic knowledge of diabetes and diagnosis, chronic complications of diabetes, self-care in daily life, and hypoglycemic drug use. The response choices are true, false, and unknown. For positive items, respondents receive "1" when answering "true" and "0" when answering "false" and "unknown." In contrast, for negative items, respondents receive "1" when answering "false" and "0" when answering "true" and "unknown." The total possible score ranges from 0 to 21. A higher score indicates higher diabetes knowledge.[33]

The Diabetes Empowerment Process Scale developed by Chen et al.[16] was used to measure empowerment perception. It has 15 items in four subscales: mutual participation (4 items), raising awareness (4 items), providing necessary information (3 items), and open communication (4 items). Items are rated on a 5-point Likert scale from 0 (strongly disagree) to 4 (strongly agree). The possible total score ranges between 0 and 60, where higher scores indicate greater empowerment perception.[16]

The Provider-patient Communication Scale developed by Xu[13] and translated into Thai by Pinprapapan et al.[34] was used to measure provider-patient communication. It consists of nine items to assess patients' perception of the provider's communication regarding general clarity (2 items), explaining medical care (4 items), and responding to patient's concerns

(3 items). Each item is rated on a 4-point Likert scale from 1 (never) to 4 (always). Negative items are reversely scored. The possible total score ranges between 9 and 36. A higher score indicates better provider-patient communication.[34]

The Social Support Questionnaire developed by Ruankham[35] was used to measure perceived social support. It has 16 items in four subscales, including emotional support (4 items), informational support (4 items), appraisal support (3 items), and instrumental support (5 items). Items are rated on a 4-point Likert scale from 1 (not at all true) to 4 (very true). Possible total scores range from 16 to 64, and a higher score indicates greater perceived social support.[35]

The MoCA-B developed by the Montreal Cognitive Assessment Clinic, Prince Mahidol Award Foundation, and Faculty of Medicine, Chulalongkorn University in Thailand[10] was used to measure cognitive function. It assesses six cognitive domains: visual perception (3 points for superimposed object); executive functioning (1 point for simplified alternating trail making; 3 points for word similarity; 3 points for problem-solving tasks); language (2 points for fruit fluency; 4 points for animal naming); attention (3 points for modified digit Stroop; memory (5 points for five-word delayed recall); and orientation (6 points for time and place). Possible total score ranges from 0 to 30, with the cut-off score under 17 indicating cognitive impairment.[36]

The Internet Use Questionnaire developed by Jiang and Beaudoin[22] was used to measure Internet use. It consists of five items about internet use for health purposes about sharing health information, participation in support groups, watching videos about health, looking for health information, and looking for health care providers. The dichotomous response choices are 1 (yes) or 0 (no). The possible total score ranges from 0 to 5, where a higher score represents greater Internet use for health purposes. [22]

The Being Actively Engaged with Society Subscale of the Active Ageing Scale for Thai People, developed by Thanakwang,[26] assesses social engagement. It incorporates eight items in two sub-domains: engaging in social participation (3 items) and social contribution (5 items). Items are rated on a 4-point Likert scale from 1 (not at all true) to 4 (very true). Possible total score ranges from 8 to 32, and higher scores indicate higher social engagement.[26]

Data Collection: This was performed between December 2019 and December 2020 after the study was approved. A list of older adults with uncontrolled diabetes in the database was requested from the 12 participating hospitals according to inclusion criteria. Potential participants visiting the hospitals were approached and given full information about the study and the decision-making autonomy. After the participants gave consent, the questionnaires were read for them to answer in a preferred place privately. Participants were allowed to take a break for 10-20 minutes. After completion, the questionnaires were checked for completeness of data.

Data Analysis: Data were analyzed using the Statistic Package for the Social Science (SPSS 26.0) and AMOS. Data cleaning procedures were performed, and the results demonstrated no missing data (response rate was 100%) and no outliers. From this process, 41 participants had a MoCA-B score of 17 and lower, which indicated suspected cognitive impairment in older adults,[36] which might hinder their ability to answer the questionnaire accurately. Thus, these 41 participants were deleted, leaving 259 participants for further analysis. Descriptive statistics were employed to describe the characteristics of the sample and study variables. Next, statistical assumptions underlying SEM were tested, including missing data, outliers, normality, linearity, homoscedasticity, and multicollinearity. The assumptions for linearity were not violated, and there were no multicollinearity issues, as evidenced by bivariate correlations of independent variables ranging from 0.36 to 0.59, which did not exceed 0.90[30] and the variance inflation factor (VIF) of 1.69-1.94 that did not exceed 2.[30] However, the data showed non-normal

distribution, so Bootstrapping was used to create multiple sub-samples from the original data.[30] Before the estimation of the full SEM, measurement model testing was performed to validate the construct validity of seven latent variables through CFA using AMOS. To test the model's goodness of fit with empirical data, six indices were considered based on the following criteria: Chi-square (χ^2) should be non-significant with p-value of higher than 0.05, χ^2/df of < 3, Goodness of Fit Index (GFI) of > 0.90, Root Mean Square Error of Approximation (RMSEA) < 0.05-0.08, and Comparative Fit Index (CFI) of > 0.90.[30]

Results

Characteristics of participants

Of the 259 participants, most were female. Their ages ranged from 60 to 85 years, with more than half being in young-old group aged 60-69. Most of them were Buddhist, married, and educated in elementary school. The mean personal income was 4,883 THB or 142.44 USD (SD = 8056.57) per month, and 56.75% of participants lived with 3-5 family members. They had been diagnosed with type 2 diabetes for an average of 9.65 years, with comorbidity. The mean FBS was 147.75 mg/dl, and the mean HbA1C was 8.09%. They received health information mainly from healthcare providers.

Scores for study variables

The mean score of overall health literacy and each subscale, access, understand, appraise, and apply, were inadequate. The mean score of cognitive function, diabetes knowledge, provider-patient communication, empowerment perception, social support, social engagement, and Internet use are shown in **Table 2.**

Table 2. Descriptive values of the study sample (n = 259)

Variables	Possible score	Actual score	Mean	SD
Overall health literacy	0-50	0.71-46.81	19.49	11.48
Accessing	0-50	0.00-50.00	17.45	12.54
Understanding	0-50	3.03-50.00	22.86	11.09
Appraising	0-50	0.00-47.22	16.51	12.15
Applying	0-50	0.00-48.48	21.80	11.34
Cognitive function	0-30	18-30	22.63	3.41
Diabetes knowledge	0-21	7-21	15.33	2.96
Empowerment perception	0-60	0-60	34.10	13.26
Provider-patient communication	9-36	13-36	29.38	4.68
Social support	16-64	32-64	50.74	7.98
Social engagement	8-32	8-32	19.26	6.14
Internet use	0-5	0-5	0.72	1.63

Note: Health literacy score correlates to 4 levels: inadequate (0-25), problematic (>25-33), sufficient (>33-42) and excellent (>42-50)[32]

Model testing

The correlation matrix among all variables is shown in **Table 3,** which indicates all variables were correlated at a moderate to high level. The structural model was tested, and the results showed that it did not fit with the data (**Table 4**). Therefore, the initial model was modified based on empirical evidence and reasonability of statistical findings (modification indices) by including double-headed arrows on the pathways to permit error correlation based on modification indices, taking into account the constructs with the highest values of error displayed by the program. The final model (**Table 4**), explaining 76% of the variance in health literacy among older adults with uncontrolled diabetes, fitted with the data (**Figure 3**).

Table 3. The correlation coefficient matrix of the study variables (n = 259)

Variables	1	2	3	4	5	6	7	8
1. Cognitive function	1.00							
2. Diabetes knowledge	.59**	1.00						
3. Empowerment perception	.44**	.45**	1.00					
4. Provider-patient communication	.45**	.48**	.48**	1.00				
5. Social support	.49**	.36**	.51**	.53**	1.00			
6. Social engagement	.54**	.49**	.50**	.42**	.45**	1.00		
7. Internet use	.54**	.49	.42**	.42**	.37**	.58**	1.00	
8. Health literacy	.65**	.62**	.60**	.50**	.52**	.64**	.61**	1.00

** = p < .01

Table 4. Comparison of the goodness-of-fit indices in the hypothesized and modified MHLTOAUD

Goodness-of-Fit Indices	Standard of Fit	Hypothesized Model	Final Model
χ^2	-	1031.232	511.270
df	-	337	309
Relative Chi-square (χ^2/df)	<3	3.060	1.655
RMSEA	0.05-0.08	0.089	0.050
CFI	>0.90	0.873	0.960
TLI	>0.90	0.858	0.955

Note: χ^2 = Chi-square; df= degree of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = Tucker-Lewis index

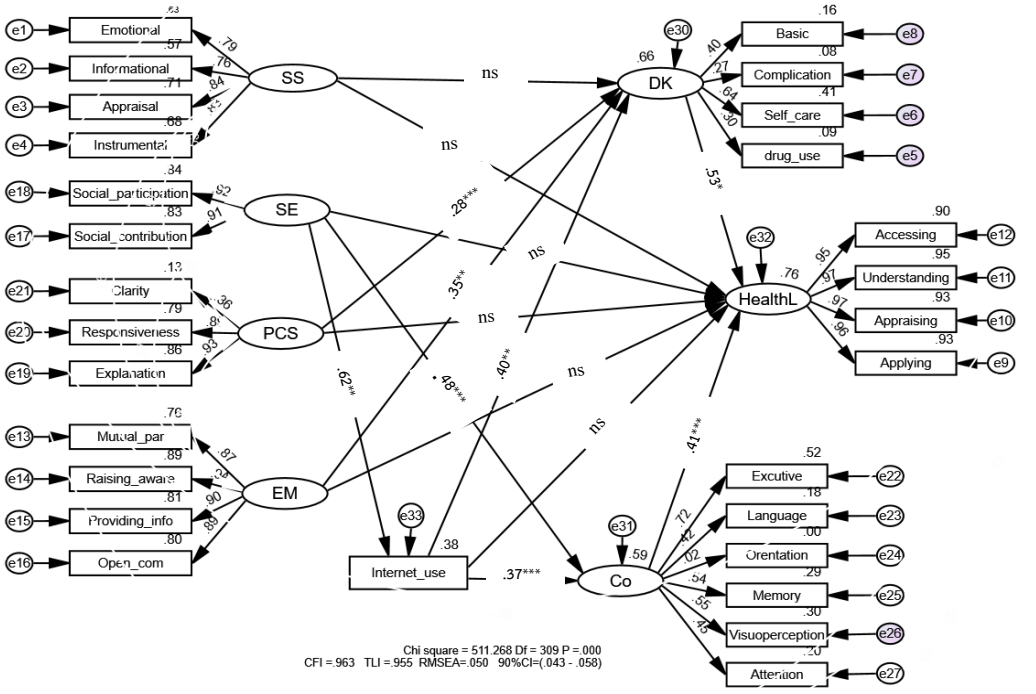

Figure 3. The final modified MHLTOAUD

Note. ns = non-significant, SS = Social support, SE = Social engagement, PCS = Provider- patient communication, EM = Empowerment perception, Co = Cognitive function, DK = Diabetes knowledge, and HealthL = Health literacy

* = p < .05 ** = p < .01 *** = p < .001

The result revealed that the final model of health literacy among older adults with uncontrolled diabetes was directly influenced by two independent variables comprising diabetes knowledge (β = .53, p < .05) and cognitive function (β = .41, p < .001). Other variables had indirect effects on health literacy through mediators. Provider-patient communication (β = .28, p < .05), empowerment perception (β = .35, p < .01), and Internet use (β = 40, p < .001) had an indirect effect on health literacy through diabetes knowledge, altogether explaining 66% of variance in diabetes knowledge (R^2 = .66). Social engagement (β = .48, p < .001) and Internet use (β = .37, p < .001) indirectly affected health literacy through cognitive function, explaining 59% of variance in cognitive function (R^2 = .59). However, social support had neither significant direct nor indirect effect on health literacy (**Table 5, Figure 3**).

Table 5. Direct and indirect standardized coefficients for the final MHLTOAUD

Causal Variables	Internet Use			Cognitive Function			Diabetes Knowledge			Health Literacy		
	DE	IE	TE	DE	IE	TE	DE	IE	TE	DE	IE	TE
Social support	-	-	-	-	-	-	.05	-	.05	.08	.03	.11
Social engagement	.62***	-	.62	.48***	.23	.71	-	.25	.25	.11	.37	.48
Provider-patient communication	-	-	-	-	-	-	.28*	-	.28	-.10	.14	.04
Empowerment perception	-	-	-	-	-	-	.35**	-	.35	.06	.18	.24
Internet use	-	-	-	.37***	-	.37	.40***	-	.40***	-.08	.36	.28
Cognitive function	-	-	-	-	-	-	-	-	-	.41	-	.41
Diabetes knowledge	-	-	-	-	-	-	-	-	-	.53*	-	.53
Explained Variance	R^2= .38			R^2= .59			R^2= .66			R^2= .76		

Note. DE = direct effect, IE = indirect effect, TE = total effect
* = p < .05 ** = p < .01 *** = p < .001

Discussion

Overall, we found that the participants had inadequate health literacy (mean = 19.49, SD = 11.48), consistent with previous research reporting that older adults with diabetes had health literacy at an inadequate level.[8] It is possible that older age leads to functional, cognitive, and psychological declines, which might be a barrier to health literacy.[11] Most participants graduated from elementary school (87.64%), which only allowed them to read, write, and calculate basic numbers, which might not be sufficient to improve health literacy.[37] This finding affirmed that older adults with uncontrolled diabetes with inadequate health literacy would have problematic abilities in accessing, understanding, appraising, and applying health information, possibly leading to poor self-care activities, low-risk prevention, and insufficient health promotion for glycemic control. In line with another study, older adults with inadequate health literacy were likelier to have poor glycemic control with higher HbA1C than those with adequate health literacy.[8]

The findings revealed that diabetes knowledge and cognitive function directly affected health literacy. Provider-patient communication and empowerment perception indirectly affected health literacy via diabetes knowledge, while social engagement affected health literacy through cognitive function. Interestingly, Internet use indirectly influenced health literacy via diabetes knowledge and cognitive function. Overall, the finding supported the Integrated Model of Health Literacy[9], in which diabetes knowledge and cognitive function are personal determinants. In contrast, provider-patient communication, empowerment perception,

and Internet use are situational determinants, and social engagement is a societal determinant influencing health literacy.

Findings from our study highlighted that only the personal determinants of individual characteristics (diabetes knowledge and cognitive function) directly affected health literacy among older adults with uncontrolled diabetes. Diabetes knowledge, one of the personal determinants of health literacy, had the strongest effect on health literacy. A possible explanation is that diabetes knowledge is an essential foundation for health literacy and diabetes self-care activity in older adults with diabetes.[6] With good knowledge and understanding of diabetes care, older adults might develop the capability to learn and confidence in accessing more health information. Therefore, they might acquire critical thinking skills and apply health information in self-care to make better health decisions. This result was in accordance with a previous study.[6]

Cognitive function had a significant direct effect on health literacy among older adults with uncontrolled diabetes. A possible explanation is that health literacy involves the competencies associated with accessing, understanding, appraising, and applying health information, which require specific cognitive qualities.[38] Cognitive function covers various processes of the mind (e.g., perceptions, attention, memory, decision-making, and language comprehension) that serve essential roles in health literacy. To understand, appraise, and apply health information, older adults need attention to focus on the information to retain that information in their memory and utilize it later to make a decision. Moreover, executive functions are required to plan and organize health information to make effective decisions.[38] Older adults with good executive functions tend to have the information-processing ability essential for appraising health information. The finding of this study was in line with previous research.[11]

Regarding situational determinants (provider-patient communication, empowerment perception, and Internet use) and societal determinants (social engagement), these factors did not affect health literacy directly but indirectly through personal determinants of cognitive function and diabetes knowledge. A probable explanation is that situational determinants serve as either facilitators or barriers. In contrast, societal determinants are social conditions where people live, which influence personal determinants of health literacy.[9] In particular, older adults with uncontrolled diabetes who had interpersonal communication with healthcare providers and shared health information could develop greater diabetes knowledge. Moreover, older adults were empowered, whereby health care providers shifted power to them, made them aware of their problems, and allowed them to make their own decisions. These matters increased trust, facilitated information exchange, and supported autonomy, helping them become active learners able to seek health information and develop more diabetes knowledge. Additionally, older adults with uncontrolled diabetes who used online communication systems for health purposes tended to have many opportunities to obtain information since abundant health information is currently disseminated online, which helps to develop diabetes knowledge. Therefore, provider-patient communication, empowerment perception, and Internet use gave older adults several opportunities to gain information and improve their diabetes knowledge. With knowledge and understanding regarding diabetes care, older adults with uncontrolled diabetes could develop the capability to learn and gain confidence in accessing, understanding, critically analyzing, appraising, and acting independently on health information for engagement in self-care, risk prevention, and health promotion.

Internet use also indirectly affected health literacy through cognitive function because it allows older adults to receive information that is transformed, reduced, elaborated, stored, recovered and used, and this helps to develop their cognitive function to learn new information and, therefore, improve their health literacy. This finding confirms previous research that frequent Internet use contributed to better cognitive reserves and might minimize cognitive decline among

older adults.[11,24] The result was also consistent with Zhao et al.[24] who found that Internet use was associated with improved memory.

In this study, social engagement affected health literacy through cognitive function. As older adults with uncontrolled diabetes engaged in society by participating in collective activities, they had interaction and social exchange with other people, which reinforced social capital and social norms, contributing to the development of both social and cognitive skills. This finding was aligned with prior research confirming that more diversity and a higher frequency of social participation were associated with improved cognitive function. [29]

Furthermore, social engagement affected health literacy through Internet use and cognitive function. Social engagement serves as a channel for older adults to access health technology. Older adults with active engagement in social activities tended to use the Internet more for purposes related to health. With communication and social collaborations through Internet use for health purposes, older adults with uncontrolled diabetes could access more information, learn, and interact with others, enhancing cognitive function. Internet use could predict improved cognitive function among older adults.[11,24] Good cognitive function allowed them to understand and transform sensory input, solve problems, think abstractly, and make good judgments. Such processes enabled them to develop competency in accessing, understanding, appraising, and applying health information to make decisions on health care, promotion, and prevention.

However, the results showed that social support did not significantly affect health literacy. The result is inconsistent with the Integrated Model of Health Literacy in which social support is a situational determinant and friendly environment that influences health literacy by facilitating individuals to access, understand, appraise, and apply health information.[9] A possible explanation is that social support in the context of older adults with uncontrolled diabetes mainly focuses on diabetes care through informational support by giving health recommendations to follow; instrumental support by supplying food, money, and commodities, arranging a suitable environment, and assisting for physician's appointments and health care services; emotional support by giving hope, encouraging, and motivating self-care activities; and appraisal support by providing feedback to improve their health behaviors. Consistently, older adults with diabetes received family support to follow diabetes self-care aspects, including diet plans for diabetes, foot care, physical activity, blood glucose assessment, and dealing with feelings from diabetes.[39] Nevertheless, these supports might not enhance the capability to access health information by themselves, understand the health information, analyze the obtained health information, or apply it to make decisions for their health care.

Another possible reason may be the Thai culture, where children are expected to support their parents in old age, particularly those with chronic illnesses.[40] Therefore, social support generally aims to facilitate convenience in daily living but does not stimulate older adults to perform tasks alone. Thus, social support in the Thai context might not help older adults become active learners to develop their capability to access health information from various sources, understand the received health information, appraise the reliability of health information, or apply it to make decisions for their health care.

Limitations and Recommendations

Our study had some limitations. With a cross-sectional design, interpreting causal influences must be cautious. Most participants were in the young age group. Thus, the generalizability of the findings to middle and old-old ages may be limited. This study used a minimum sample size for structural equation modeling. Further research should be conducted in a heterogeneous population of older adults in terms of age group using a larger sample to improve the generalizability of causal modeling results.

Conclusion and Implications for Nursing Practice

Our findings illustrate causal pathways of personal, situational, societal and environmental factors influencing health literacy, particularly diabetes knowledge, which is a personal factor with the strongest influence on health literacy, followed by cognitive function. Nurses can apply the findings in designing programs that emphasize promoting diabetes knowledge and cognitive function, which are the powerful factors of health literacy, while integrating Internet use, social engagement, and empowerment communication strategies to achieve higher health literacy in older adults with uncontrolled diabetes.

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แบบจำลองเชิงสาเหตุของความรอบรู้ด้านสุขภาพในผู้สูงอายุไทยโรคเบาหวานที่ควบคุมไม่ได้

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บทคัดย่อ: โรคเบาหวานที่ควบคุมไม่ได้ในผู้สูงอายุนำมาซึ่งภาวะแทรกซ้อนทั้งเฉียบพลันและเรื้อรังที่คุกคามสุขภาพและชีวิต ความรอบรู้ด้านสุขภาพมีความสำคัญต่อความสามารถในการจัดการสุขภาพและความสำเร็จในการเปลี่ยนแปลงพฤติกรรมเพื่อผลลัพธ์ของโรคเบาหวานที่เหมาะสม อย่างไรก็ตามยังขาดความเข้าใจที่ชัดเจนเกี่ยวกับปัจจัยและกลไกที่มีอิทธิพลต่อความรอบรู้ด้านสุขภาพ การวิจัยเชิงพรรณนาแบบภาคตัดขวางนี้มีวัตถุประสงค์เพื่อทดสอบแบบจำลองของความรอบรู้ด้านสุขภาพของผู้สูงอายุไทยที่เป็นโรคเบาหวานที่ควบคุมไม่ได้ และศึกษาเส้นทางอิทธิพลของการทำหน้าที่ด้านการรู้คิด ความรู้โรคเบาหวาน การสื่อสารระหว่างผู้ให้บริการและผู้ป่วย การรับรู้การเสริมสร้างพลังอำนาจ การสนับสนุนทางสังคม การใช้อินเทอร์เน็ต และการมีส่วนร่วมทางสังคมต่อความรอบรู้ด้านสุขภาพ กลุ่มตัวอย่างเป็นผู้สูงอายุโรคเบาหวานที่ควบคุมไม่ได้ จำนวน 259 คน เก็บรวบรวมข้อมูลโดยใช้แบบสอบถามข้อมูลส่วนบุคคล แบบสอบถามความรอบรู้ด้านสุขภาพ แบบวัดความรู้โรคเบาหวาน แบบวัดกระบวนการเสริมสร้างพลังอำนาจโรคเบาหวาน แบบวัดการสื่อสารระหว่างผู้ให้บริการและผู้ป่วย แบบสอบถามการสนับสนุนทางสังคม แบบทดสอบการรู้คิดพื้นฐานมอนทรีออล แบบสอบถามการใช้อินเทอร์เน็ต และแบบวัดย่อยของการมีส่วนร่วมทางสังคม วิเคราะห์ข้อมูลโดยใช้สถิติพรรณนาและการสร้างแบบจำลองสมการโครงสร้างด้วยโปรแกรม AMOS

ผลการวิจัยพบว่าแบบจำลองอธิบายความแปรปรวนของความรอบรู้ด้านสุขภาพได้ร้อยละ 76 ความรู้โรคเบาหวานและการทำหน้าที่ด้านการรู้คิดมีอิทธิพลทางตรงต่อความรอบรู้ด้านสุขภาพ การสื่อสารระหว่างผู้ให้บริการและผู้ป่วย และการรับรู้การเสริมสร้างพลังอำนาจมีอิทธิพลทางอ้อมต่อความรอบรู้ด้านสุขภาพผ่านทางความรู้โรคเบาหวาน การมีส่วนร่วมทางสังคมส่งผลต่อความรอบรู้ด้านสุขภาพผ่านทางการทำหน้าที่ด้านการรู้คิด การใช้อินเทอร์เน็ตส่งผลต่อความรอบรู้ด้านสุขภาพผ่านทางการทำหน้าที่ด้านการรู้คิดและความรู้โรคเบาหวาน พยาบาลควรพัฒนากลยุทธ์โดยบูรณาการการใช้อินเทอร์เน็ตและการมีส่วนร่วมทางสังคมในโปรแกรมการสื่อสารเสริมสร้างพลังอำนาจเพื่อพัฒนาความรู้โรคเบาหวานและการทำหน้าที่ด้านการรู้คิดเพื่อเพิ่มความรอบรู้ด้านสุขภาพในประชากรกลุ่มนี้

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คำสำคัญ: แบบจำลองเชิงสาเหตุ ความรอบรู้ด้านสุขภาพ ผู้สูงอายุ คุณภาพชีวิต แบบจำลองสมการโครงสร้าง เบาหวานที่ควบคุมไม่ได้

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