ORIGINAL ARTICLE

A causal relationship model of factors influencing glycaemic control among pre-diabetes in Phrom Phiram district Phitsanulok province, Thailand

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ABSTRACT

This study aims to examine the causal relationship model of the factors influencing glycaemic control among the pre-diabetic population of the Phrom Phiram district, Phitsanulok province. A two-stage sampling was used to recruit 530 pre-diabetic individuals, and the data were collected using a questionnaire with a reliability value between 0.83- 0.95. Data were analysed using descriptive statistics and a causal relationship model using path analysis. The study results found that 80.0% of participants were Thai, followed by 14.3% from the Lao Krang ethnic group, and 4.9% were Thai of Chinese origin, respectively. Of the participants, 58.5% were female, with a mean age of 49.59, and 42.5% had completed primary school-level education. The average income was 10,000 baht, and 77.2% had a family history of diabetes. Approximately 76.6% had a duration of pre-diabetes of 1-6 years, with a mean fasting blood sugar level of 112.57 mg./dl. The analysis of the causal relationship model illustrated by social support demonstrated a direct effect on health literacy ($\beta = 0.68$, p-value < 0.05) and explained the variance at 46%. On the other hand, social support had an indirect effect on intention ($\beta = 0.53$, p-value < 0.05). Meanwhile, attitude ($\beta = -0.22$, p-value < 0.05), norm ($\beta = 0.90$, p-value < 0.05), and health literacy ($\beta = 0.78$, p-value < 0.05) had a direct effect on intention and co-explained the variance in intention at 100%. Then, health literacy ($\beta = 0.33$, p-value < 0.05), self-efficacy ($\beta = 0.22$, p-value < 0.05), and intention ($\beta = -0.65$, p-value < 0.05) had a direct effect on glycaemic control behaviour and co-explained the variance at 40%. Glycaemic control behaviour explained the variance in blood sugar levels at 100%. In conclusion, three factors in preventing new diabetic patients in the risk group are health literacy, intention, and behaviour to control blood sugar.

Keywords:
pre-diabetes; type 2 diabetes; glycaemic control behaviour; social support; self-efficacy; health literacy

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INTRODUCTION

The World Health Organization's report on the causes of death found that non-communicable disease (NCD) caused 60.8% of all deaths globally in the year 2000 and the percentage of total deaths caused by non-communicable diseases increased to 73.6% in 2019. This means that the average number of deaths caused by non-communicable diseases rose by 12.8%. Diabetes mellitus is one of the fastest-growing global health challenges. Diabetes mellitus was ranked as the 9th in deaths caused globally and the 8th cause of disability.[1] The information from the International Diabetes Federation found that the number of patients with diabetes mellitus (DM) had been increasing worldwide. Type 2 diabetes mellitus (T2DM) comprises 90% of the people with diabetes around the world. Among these, more than 80% of people live in developing countries. In 2021, 537 million people were suffering from type 2 diabetes mellitus. By 2045 approximately 783 million people will be living with type 2 diabetes mellitus and the estimated cost of diabetes is projected to reach up to one quarter of total health expenditure. This means an increase of 316% or about 966 billion US dollars world-wide.[2]

The highest prevalence of type 2 diabetes mellitus in 2021 was reported in the Middle East and North Africa at 18.1% but the greatest incidence of type 2 diabetes was observed in the Western Pacific region. There were 205 million cases (prevalence of 9.9%). Among the Western Pacific countries, the top 4 with the highest prevalence are China, Indonesia, Thailand, and Japan (10.6%, 10.6%, 9.7%, and 6.6% respectively).[2] In Thailand, the results from the national health examination survey indicated that the prevalence rate of type 2 diabetes mellitus was more likely to increase significantly. The prevalence rate of type 2 diabetes mellitus was 8.9% in 2014[3] and rose to 9.5% in 2020 .[4] The regions of Thailand that have the highest prevalence of type 2 diabetes, in the top 3, are the northern region, the second was central region and the third was the southern region. The top 3 health regions were Health Region 7, Health Region 2, and Health Region 3 (10.5%, 9.81%, and 9.71%, respectively).[5] In 2021, Health Region 2 found that Phitsanulok province had the highest prevalence rate of type 2 diabetes (11.12%).[5] The reason for the increase in the number of type 2 diabetes was new cases of type 2 diabetes arising from pre-diabetes. Pre-diabetes is a condition where a person's blood sugar level is elevated but below the definition of type 2 diabetes.[6] A study of epidemiology revealed that individuals with pre-diabetes have a 5-fold increased risk of type 2 diabetes mellitus[7] and all-cause morbidity such as a 1.21-fold risk of cardiovascular disease, a 1.12-fold risk of chronic kidney disease, and a 1.15-fold risk of coronary heart disease. Approximately 25% of the individuals with pre-diabetes will progress to type 2 diabetes within 3-5 years, and 70% will develop type 2 diabetes within their life.[8]

Phrom Phiram district had the highest morbidity rate of new type 2 diabetes cases developing from pre-diabetes in Phitsanulok province. [9,10] The report of the Health Data Centre (HDC) during the 2020-2023 period found that the morbidity rate of new type 2 diabetes cases from pre-diabetes was 2.65%, 2.76%, 2.71%, and 2.9%, respectively. In the same way, the prevalence rate of pre-diabetes was 12.07%, 16.21%, 16.38%, and 15.42 % respectively. This trend indicated that the prevalence of pre-diabetes has been increasing over time.[11] It showed that focusing on pre-diabetes was an important part of reducing the incidence of new type 2 diabetes cases.

Previous studies have found that glycaemic control behaviours influence blood sugar levels.[12-14] Meanwhile, health literacy and self-efficacy are associated with glycaemic control behaviours.[13-17] For instance, attitude and norms are associated with intention.[16-19] Additionally, social support is associated with health literacy.[13,15] The theory of the concept of planned behaviour indicates that internal and external factors are associated with and influence the behaviour of people. Path statistical analysis is suitable for studying and explaining the complex relationship between direct and indirect influencing variables. The direct and indirect path influences between the external and internal variables that appear in the model developed for this study. The present study focuses on modifiable factors toward glycaemic control in individuals with pre-diabetes, the researcher adopted theories used as a framework for this study including the theory of planned behaviour, [20] social support,[21] and health literacy.[22] The purpose of this study was to investigate a causal relationship model of factors influencing blood sugar levels among the pre-diabetes population in Phrom Phiram district, Phitsanulok province. The findings can be utilized to develop a model to promote glycaemic control behaviour for pre-diabetes in the future.

METHODOLOGY

Study Population

The study population consisted of 4,569 individuals with pre-diabetes[23] identified from the diabetes risk screening report.[11]The data collection was conducted from May to July 2024.

The inclusion criteria are as follows: 1) aged between 35-59 years, 2) have lived in the investigated community in the ensuing 6 months, 3) able to communicate and understand Thai language, and 4) willing to participate in this study. The exclusion criteria: participants moved out from the study area during data collection.

Sample size

This study had 16 variables classified as 4 exogenous variables including social support (healthcare provider support, the support of village health volunteers, the support of friends, and family), attitude, self-efficacy, and norms; a total of 7 variables. There were 4 endogenous variables including health literacy (cognitive skills, access skills, communication skills, decision making skills, media literacy skills, and self-management skills), intentions, glycaemic control behaviours, and FBS. The total number of variables was 9. The sample size of this study was calculated at 30-fold of predictor variables.[24] In this case, there are 16 predictor variables, then, the number of participants was 480 cases. To deal with missing data exceeding 10%, the sample size was increased to 530 cases. [25] The samples were recruited using a two-stage sampling method including simple random sampling and systematic random sampling. The first stage used simple random sampling. The second stage used systematic random sampling. In the study, the researcher conducted a test of the sampling procedure at Phrom Phiram Subdistrict by the sampling interval formula with N/n, which resulted in an interval of 5 counting units. The researcher then used simple random sampling from member numbers 1-5, taking 1 number as the starting number of the random sampling, and randomly selecting the next sequence with an interval of 5 counting units until the target sample was complete according to the specified number. The same random sampling method was used in the remaining subdistricts until a sample of 530 people was obtained.

Research Instrument

A questionnaire based on previous studies[12-13] was developed and used for data collection. Validity and reliability tests

were performed on 30 individuals with pre-diabetes.

The questionnaire consisted of 8 parts as follows:

Part 1: Personal characteristics; including gender, age, ethnicity, educational level, income, duration of pre-diabetes, family history of diabetes, and fasting blood sugar levels from the report.

Part 2: Social support; the social support was classified into 4 categories: healthcare providers, village health volunteers, friends, and family had 16 items. The scale for measuring was a 3-point Likert-type scale, with 0=never, 1=sometimes, and 2=regular. The reliability value was 0.88.

Part 3: Attitude; the attitude toward glycaemic control in individuals with pre-diabetes had 10 items. The scale for measuring was a 3-point Likert-type scale, with 0=disagree, 1=not sure, and 2= agree, respectively. The reliability value was 0.84.

Part 4: Self-efficacy; The self-efficacy toward glycaemic control had 10 items. The scale for measuring was a 3-point Likert-type scale, with 0=not confident at all, 1=somewhat confident, and 2= confident. The reliability value was 0.86.

Part 5: Norm; the normative beliefs toward glycaemic control had 10 items. The scale for measuring was a 3-point Likert-type scale, with 0= can't imitate, 1=not sure, and 2= can imitate. The reliability value was 0.88.

Part 6: Intention; the intention toward glycaemic control had 10 items. The scale for measuring was a 3-point Likert-type scale, with 0= can't do, 1=not sure, and 2= can do. The reliability value was 0.95.

Part 7: Health literacy; health literacy toward glycaemic control was classified into 6 categories: cognitive skills, access skills, communication skills, decision making skills, media literacy skills, and self-management skills had 26 items. The scale for measuring was a 3-point Likert-type scale, with 0=not true, 1=not sure, and 2=true. The reliability value was 0.92.

Part 8: Glycaemic control behaviour; there were 12 items including 6 essential behaviours with healthy eating, physical activity, problem-solving, reducing risks, healthy coping, and the monitoring of blood sugar level. The scale for measuring was a 3-point Likert-type scale, with 0=never, 1=sometimes, and 2=regular. The reliability value was 0.83.

Data collection

The researcher made an appointment with the participants at the primary care unit to explain the objective of the study and ask for their cooperation in data collection. Then, the participants signed the consent form agreeing to participate in the study. Then, the participants completed the questionnaire by themselves. A questionnaire contained standard definitions and other information notes and remained confidential, thus protecting the anonymity of the participants. This research was conducted between May to July 2024.

Data analysis

The researcher explained the characteristics of the samples with descriptive statistics (frequency, maximum, minimum, mean, standard deviation, and percentage). A causal relationship model is analysed by path analysis to identify the direct and indirect effects of social support, attitude, intention, norm, health literacy, self-efficacy, glycaemic control behaviours, and blood sugar levels. The criteria used to test the model fit are as follows: Chi-Square/ df < 2, P-value> 0.05, goodness of fit index (GFI)≥ 0.90, adjusted goodness of fit index (AGFI)≥ 0.90, standardized root mean square residual (SRMR)≤ 0.05, root mean square error of

approximation (RMSEA) ≤ 0.05 and critical N (CN) > 0.05.[26]

RESULTS

Personal characteristics of participants

The results found that the participants were predominantly Thai (80.8%), followed by Lao Krang ethnic group (14.3%), and Thai of Chinese origin (4.9%). Of the participants, 58.5% were female, 55.6% were more than 50 years of age. The mean age was 49.59 years with an S.D. of 7.15. Of the participants, 42.5% had a primary school level of education, and 86.8% of the participants had a monthly income of less than 15,000 baht, with a mean of 10,000 baht, with an S.D. of 7,243.84. Approximately, 76.6% of the participants had a history of pre-diabetes of 1-6 years, with a mean of 4.56 years and an S.D. of 2.91. About 77.2 % of the participants had a family history of diabetes. Of the participants, 42.5% had a fasting blood sugar level of 100-109 mg./dl, with a mean of 112.57 mg./dl and an S.D. of 8.80, as shown in Table 1.

Table 1. Personal characteristics of participants (n=530)

Personal characteristics	Number	Percent
Gender		
Male	220	41.5
Female	310	58.5
Age		
≤ 39 years	62	11.8
40-49 years	172	32.6
≥ 50 years	296	55.6
$\bar{x}$= 49.59, S.D.= 7.15, Min = 35, Max = 59		
Educational level		
Primary school	225	42.5
Secondary school	191	36.0
Diploma degree	53	10.0
Bachelor degree	54	10.2
Higher than a bachelor degree	7	1.3
Monthly income		
<15,000 baht	460	86.8
15,000-30,000 baht	63	11.9
>30,000 baht	7	1.3
$\bar{x}$= 10,000, S.D.= 7243.84, Min = 600, Max = 50,000		
Duration of pre-diabetes		
1-6 years	406	76.6
7-11 years	110	20.8
12-16 years	14	2.6
$\bar{x}$= 4.56, S.D.= 2.91, Min = 1, Max = 16		
Family history of diabetes		
No	121	22.8
Yes	409	77.2
Fasting blood sugar level (FBS)		
100-109 mg./dL.	225	42.5
110-117 mg./dL.	108	20.4
118-125 mg./dL.	197	37.1
$\bar{x}$= 112.57, S.D.= 8.80, Min = 100, Max = 125		

Full model

Before testing the causal relationship model, the researcher grouped variables using factor analysis. The result showed the factor loadings (**λ**) for each indicator, the composite reliability (CR), and average variance extracted values (AVE), as shown in Table 2.

Table 2. The result of measurement model

Items		Variables	λ	CR*	AVE**
Exogenous variables					
SS (Social support)	SP	Social support from providers	0.967	0.947	0.818
	SC	Social support from village health volunteers	0.771		
	SF	Social support from friends	0.981		
	SM	Social support from family	0.885		
AT (Attitude)	T1	Attitude towards setting goals and reducing risk factor	0.809	0.790	0.559
	T2	Attitude towards dietary controls	0.637		
	T3	Attitude towards health monitoring	0.786		
SE (Self-efficacy)	E1	Self-efficacy toward diet and exercise	0.737	0.878	0.710
	E2	Self-efficacy toward health problem solving	0.995		
	E3	Self-efficacy toward communication and literacy for glycaemic control	0.773		
NOR (Norm)	N1	Norm towards health monitoring and reducing risk factors	0.852	0.921	0.797
	N2	Norm towards dietary supplements/herbal remedies and exercise	0.836		
	N3	Norm towards dietary controls	0.984		
Endogenous variables					
HL (Health literacy)	H1	Health literacy of Cognitive skills	0.719	0.871	0.534
	H2	Health literacy of Access skills	0.712		
	H3	Health literacy of Communication skills	0.653		
	H4	Health literacy of Decision skills	0.898		
	H5	Health literacy of Media literacy skills	0.730		
	H6	Health literacy of Self-management skills	0.647		
IN (Intention)	I1	Intention towards dietary supplements/herbal remedies and exercise	0.658	0.873	0.701
	I2	Intention towards reducing risk factors and monitoring blood sugar levels	0.955		
	I3	Intention towards dietary controls	0.872		
GCB (Glycaemic control behaviour)	B1	Behaviour of diet and exercise	0.722	0.810	0.588
	B2	Behaviour of health coping skills and problem solving	0.795		
	B3	Behaviour of reducing risks and health monitoring	0.782		
FBS (Fasting blood sugar)	BS	Blood sugar levels	0.857	0.734	0.734

*CR ≥0.6 **AVE ≥0.5 [33]

Testing the causal relationship model by path analysis demonstrates a good fit model, with Chi-Square/df =1.17, P-value=0.0576, GFI=0.99, AGFI=0.97, SRMR=0.030, RMSEA=0.018, CN=706.08, and the relationship between the variables, are shown in Figure 1 below.

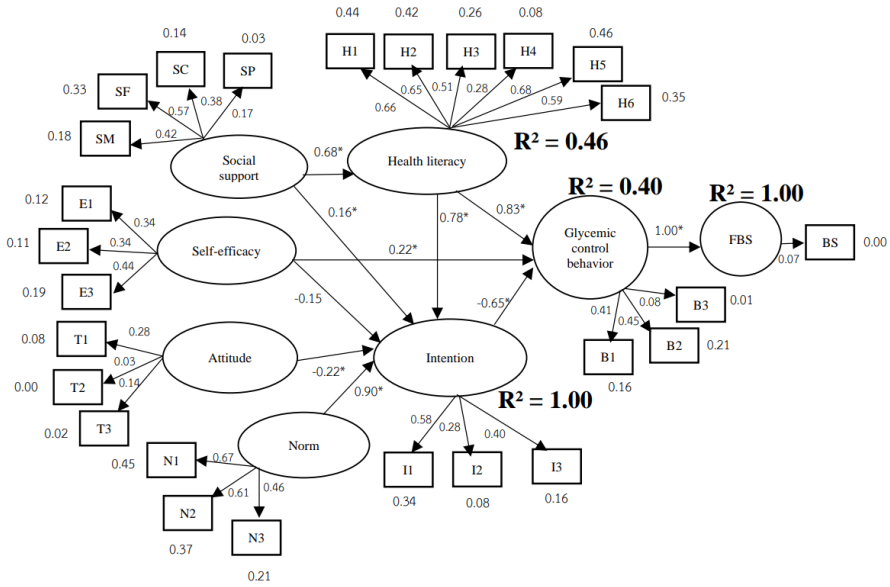

Figure 1. A causal relationship model of the factors influencing glycaemic control among pre-diabetes patients, * P-value< 0.05 [Source: Author's own]

The results from each variable analysis were as follows: 1) social support affected health literacy at a total effect value of 0.68. 2) Norm had the highest effect on intention, health literacy, social support, and attitude at a total effect value of 0.90, 0.78, 0.53, and -0.22 respectively. 3) intention had the highest effect on glycaemic control behaviour, norm, social support, health literacy, and self-efficacy at a total effect value of -0.65, -0.58, 0.39, 0.33, and 0.31 respectively. 4) glycaemic control behaviour had the highest effect on fasting blood sugar levels, intention, norm, social support, health literacy, and self-efficacy at a total effect value of 1.00, -0.65, -0.58, 0.39, 0.33, and 0.31 respectively, as shown in Table 3.

Table 3. The direct effect (DE), indirect effect (IE), and total effect (TE) after adjusting the model

Cause Variables	Effect Variables											
	HL			IN			GCB			FBS		
	DE	IE	TE	DE	IE	TE	DE	IE	TE	DE	IE	TE
SS	0.68*	-	0.68*	-	0.53*	0.53*	0.17	0.22*	0.39*	-	0.39*	0.39*
SE	-	-	-	-0.15	-	-0.15	0.22*	0.09	0.31*	-	0.31*	0.31*
AT	-	-	-	-0.22*	-	-0.22*	-	0.14	0.14	-	0.14	0.14
NOR	-	-	-	0.90*	-	0.90*	-	-0.58*	-0.58*	-	-0.58*	-0.58*
HL	-	-	-	0.78*	-	0.78*	0.33*	-	0.33*	0.33*	-	0.33*
IN	-	-	-	-	-	-	-0.65*	-	-0.65*	-0.65*	-	-0.65*
GCB	-	-	-	-	-	-	-	-	-	1.00*	-	1.00*

* P-value< 0.05, SS = Social support, SE = Self-efficacy, AT = Attitude, NOR = Norm, HL = Health literacy, IN = Intention, GCB = Glycaemic control behaviour, FBS = Fasting blood sugar level.

The result concluded that the causal relationship model from exogenous and endogenous variables affecting glycaemic control behaviour and fasting blood sugar levels in individuals with pre-diabetes was able to describe social support and explain the variance in health literacy at 46%. Then, together social support, attitude, norm, and

health literacy explained the variance in intention at 100%. Meanwhile, together, health literacy, self-efficacy, and intention explained the variance in glycaemic control behaviour at 40%. Finally, glycaemic control behaviour explained the variance in fasting blood sugar levels at 100%.

DISCUSSION

The results of this study indicated that the norm had a positive direct effect on intention($\beta = 0.90$, p-value < 0.05) and a negative indirect effect on fasting blood sugar levels through glycaemic control behaviour ($\beta_{indirect} = -0.58$, p-value < 0.05). Namely, the norm was an important external factor affecting an individual's intention and was associated with glycaemic control behaviour.[27] This finding's initial evidence explained that external factors or social resources on glycaemic control for pre-diabetes would be a challenge in providing better health care. These results are similar to a previous study in China which found that social norm was the strongest predictor of behavioural intention ($\beta = 0.314$, p-value < 0.05)[17]. Then, behavioural intention and perceived behavioural control directly affected an individual's behaviour ($\beta = 0.452$, $\beta = 0.452$, p-value< 0.05 respectively).[17] This showed that an individual's behaviour modification should focus on modifying social norms towards glycaemic control with external factors by promoting peer or family emphasis on health.[28]

For social support, there was a positive direct effect on health literacy ($\beta = 0.68$, p-value < 0.05). Then, a positive indirect effect on intention ($\beta_{indirect} = 0.53$, p-value < 0.05) and an indirect effect on fasting blood sugar levels through glycaemic control behaviour ($\beta_{indirect} = 0.39$, p-value < 0.05). Similar to earlier evidence in pre-diabetes, which indicated that the factor that had an indirect influence on glycaemic control was social support ($\beta_{indirect} = 2.14$, p-value < 0.05).[12] In the same way, previous studies of social support on the elderly with type 2 diabetes have found that social support demonstrated a direct effect on health literacy ($\beta = 0.27$, p-value < 0.05) and a direct effect on glycaemic control behaviour ($\beta = 0.08$, p-value < 0.05).[13] Additionally, the study of diabetic patients demonstrated social support had a positive indirect influence on the individual's behaviour in taking personal responsibility for controlling their blood sugar levels.[15]

For self-efficacy, there was a positive direct effect on glycaemic control behaviour ($\beta = 0.22$, p-value < 0.05) and an indirect effect on fasting blood sugar levels ($\beta_{indirect} = 0.31$, p-value < 0.05). A study done in China found that intention and perceived variance in self-care behaviour stood at 60%.[17] This is consistent with previous studies that found self-efficacy had a positive direct influence on behaviour for controlling blood sugar levels.[13,29] Namely, the glycaemic control behaviour will be positive or negative depending on self-efficacy.[30]

For health literacy, there was also a positive direct effect on intention, glycaemic control behaviour, and fasting blood sugar levels ($\beta = 0.78$, $\beta = 0.33$, $\beta = 0.33$, p-value < 0.05 respectively). In the same way, the causal model study of elderly patients with type 2 diabetes found that health literacy had a direct effect on glycaemic control behaviour ($\beta = 0.30$, p-value < 0.05).[13] This was consistent with past studies, where it showed that health literacy was a significant factor in glycaemic control behaviour and blood sugar levels.[14-15] Pre-diabetic patients with adequate health literacy are able to improve their understanding and choices, which are relevant to their health care. This is consistent with the World Health Organization's health literacy concept, which states that cognitive and social skills

can determine their ability to take responsibility for their own health care.[31]

For glycaemic control behaviour, there was the strongest direct effect on the fasting blood sugar level (β = 1.00, p-value < 0.05) which explains the variance in fasting blood sugar level at 100%. It shows that glycaemic control behaviour influences the normalization of blood sugar levels among pre-diabetics. Likewise, the previous study found that direct and indirect variables may affect blood sugar levels through preventive behaviours.[12] Similarly, the study of Phungdee, Sirisopon, and Rawdaree[29] found that dietary behaviour to control blood sugar levels affects blood sugar levels at 83%, showing that pre-diabetic patients who have good glycaemic control behaviour can control their fasting blood sugar levels. On the other hand, if pre-diabetic patients have bad glycaemic control behaviour, they could develop uncontrolled fasting blood sugar levels.

In the case of attitude and intention, it was found that they did not conform to the theory of planned behaviour. It may be seen that attitude had a negative direct effect on the intention (β = -0.22, *p*-value < 0.05). Several studies on attitude towards glycaemic control found that attitude affected self-care.[12,16] Meanwhile, previous studies on glycaemic control behaviour among pregnant women with gestational diabetes mellitus (diabetes mellitus during pregnancy), found that attitude had a positive direct effect on intention (β = 0.28, *p*-value < 0.05). It indicated that the maturity of health care exhibited self-accountability.[27] A possible explanation of this result might be that the participant's attitude was that the person is healthy and is not a patient with type 2 diabetes. This would affect the participants' intentions toward glycaemic control behaviour. Even though, higher-healthy behavioural intentions may affect their better health result, people may choose lower-healthy behavioural intentions in order to reduce the cognitive dissonance between their attitudes and rational realization of the cost of behaviour in terms of time, convenience, financial costs, and effort. Consistent with the behavioural cost study which stated that a person formulate attitude toward behaviour can vary depending on the cost intensity of the behaviour.[34]

For intention, there was a negative direct effect on glycaemic control behaviour and fasting blood sugar level (β = -0.65, *p*-value < 0.05). Previous studies, similar to this, found that intention was correlated significantly with behaviour.[17,19] Comparatively, the study on behaviour to control blood sugar levels among patients with type 2 diabetes found that intention had a positive direct effect on glycaemic control behaviour (β = 0.31, *p*-value < 0.05) and a negative indirect effect on fasting blood sugar levels (β = -0.28, *p*-value < 0.05). It indicated that the positive action of intention had a positive influence on good behaviours and affected low blood sugar levels.[29] Consistent with the theory of planned behaviour concept, which states that behaviour is formed as the result of intention regarding health-related actions.[20] However, a possible explanation for this result is that despite the strengthened intention, people often refrain from action on intended behaviours due to barriers such as motivation, stress, or other priorities. This phenomenon is referred to as the intention-behaviour gap.[32]

Another important finding was that the causal relationship model of the factors influencing glycaemic control among individuals with pre-diabetes found that social support was the most important variable and could explain 46% of the variance in health literacy. Meanwhile, social support, attitude, norm, and health literacy could co-explain 100% of the variance in intention. Then, health literacy, self-efficacy, and intention could co-explain 40% of the variance in glycaemic control behaviour. Glycaemic control behaviour was the strong variable, which

could explain the variance in fasting blood sugar levels at 100%.

LIMITATIONS OF THE STUDY

This public health study was to test the consistency of the causal relationship model of the variables influencing blood sugar control in pre-diabetic patients. Under the theory, the study was related to real data collected in the area at that time that cannot establish cause-and-effect or temporal sequence of pre-diabetes events. The study concerns patients in the pre-diabetic stage, but not those actually with diabetes. Given the limitations, further research is necessary in this topic area.

AUTHOR CONTRIBUTIONS

K.P. wrote the manuscript. P.S. provided data analysis table 2 and 3. All the authors contributed to the design and implementation of the study, to read and approved manuscript.

ETHICAL CONSIDERATION

This study was approved regarding human research ethics by the Human Research Ethics Committee, Naresuan University, Thailand. Approval date was 11 April 2024. (IRB No. P3-0018/2567).

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