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A causal relationship structure model of dietary behavior to control blood glucose levels of type 2 diabetes mellitus patients

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Abstract

This cross-sectional study research aims to test a causal relationship structure model of dietary behavior to control blood glucose levels of type 2 diabetes mellitus patients by developing elements from the theory of planned behavior and the self-efficacy theory. The study group consisted of 350 people with type 2 diabetes mellitus, aged between 40-59, who received medical care at Pathum Thani Hospital, Pathum Thani Province. Participants were selected by simple random sampling with a computer program to write random commands from random numbers. The instrument used for the study consisted of demographic data, a questionnaire to investigate the perceived behavioral control, intention to perform the behavior, self-efficacy to diet, and dietary behavior to control blood glucose levels questionnaire. Data were analyzed with descriptive statistics and a computer program AMOS to analyze structural equation models (SEM).

The study results revealed that a causal relationship structure model of dietary behavior to control blood glucose levels of type 2 diabetes mellitus patients fit with the empirical data and could explain 83% of the variance in dietary behavior to control blood glucose levels affecting blood sugar levels. Dietary behavior to control blood glucose levels had a direct negative effect on glycated hemoglobin levels (HbA1c) ($\beta = -0.91$, $p < .05$). The perceived behavioral control, self-efficacy to diet, and behavioral intention had a positive direct effect on dietary behavior to control blood glucose levels respectively ($\beta = 0.55$, $p < .05$; $\beta = 0.50$, $p < .05$; $\beta = 0.31$, $p < .05$). In addition, variables with an indirect effect on dietary behavior to control blood glucose levels through behavioral intention were self-efficacy in diet and behavioral control respectively ($\beta = 0.30$, $p < .05$; $\beta = 0.27$, $p < .05$).

The study concludes that the perceived behavioral control, self-efficacy to diet, and intention to perform the behavior directly affected dietary behavior to control blood glucose levels of type 2 diabetes mellitus patients.

Keywords: Causal relationship structure model, dietary behavior, control blood glucose levels, type 2 diabetes mellitus patients

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1. Introduction

Type 2 diabetes is a condition in which the body has high blood glucose levels. It is considered a public health problem since 2017, there were 425 million people with diabetes worldwide, while Thailand had 4.8 million, accounting for 8.9% of the total population. It was also found that 77.9% were unable to control HbA1c levels below 7% to achieve the target [1]. For Pathum Thani Province, it was found that diabetic patients could not control blood glucose levels in their blood, and the mortality rate of diabetes in the age of 40-59, the 4th health zone, is the highest due to the lack of health behaviors to take care of themselves. Therefore, there is a high risk of complications and premature death, consisting of 6.3% of total deaths proportional to an economic impact worth up to 24,489 million baht [2].

Factors affecting glycemic control were behavioral, psychological, motivational, and biosocial factors [3] especially dietary behavioral factors that had the greatest effect on blood glucose levels, which were able to reduce HbA1c by 1.0 – 2.0% [4]. The most effective prevention of complications is to consume sugar-free food to control blood glucose levels, eat food in the right amount, not exceed the amount of energy that should be received, and choose to eat the right types of food [5]. The key factors that had a high influence on food consumption behavior were intention to practice, behavior control perception and practical ability, which are variables from the concept of planned behavior theory and the theory of self-efficacy. This theory supports that these factors have high power in predicting health behaviors [6, 7] .

Guidelines for modifying dietary habits in diabetic patients, group processes and social support are used. Inspiration for self-regulation, education to promoting awareness of risk and severity of disease, perceived benefits and leads to action [5]. The approach has several variables involved. Event activities cannot be multiplied or service-intensive in food consumption in the context of a tertiary hospital. As a result, patients with type 2 diabetes mellitus cannot control their blood glucose levels. To promote dietary behaviors to control blood glucose levels, it is necessary to understand the causal factors of behaviors that will support or inhibit dietary behaviors for proper blood glucose control. Therefore, the researcher is interested in studying the causal relationship structure model of food consumption behavior to control blood glucose levels in patients with type 2 diabetes mellitus.

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2. Research Objectives

To examine a structural causal relationship model of dietary behavior for glycemic control in patients with type 2 diabetes.

Specific objectives

1. To demonstrate the relationship between dietary behavior for glycemic control and level of glycated hemoglobin (HbA1c).

2. To explain the relationship between perceived behavioral control, self-efficacy to diet, intention to perform the behavior, and dietary behavior to control blood glucose levels.

3. To prove the relationship between perceived behavioral control, self-efficacy to diet, intention to perform the behavior, and dietary behavior to control blood glucose levels.

3. Hypothesis

1. Dietary behavior for glycemic control has a direct negative influence on the level of glycated hemoglobin (HbA1c).

2. Perceived behavioral control, self-efficacy to diet, and intention to perform the behavior are direct positive influences on dietary behavior to control blood glucose levels.

3. Perceived behavioral control and self-efficacy to diet indirectly influence dietary behavior to control blood glucose levels through the variables of intention to perform.

4. Research Conceptual Framework

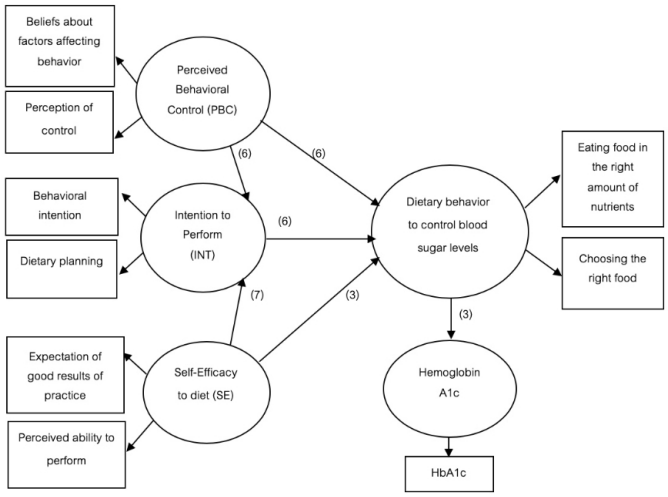

Figure 1: Research Conceptual Framework.

5. Research Methodology

This research is a cross-sectional study using Structural Equation Modeling (SEM) to examine a structural causal model of dietary behavior for glycemic control in type 2 diabetes patients in a period of three months.

5.1 Population and sample

The population in this study was 1,683 type 2 diabetic patients, aged 40-59, who attended outpatient diabetes clinic at Pathum Thani Hospital, Pathum Thani Province.

The sample size criteria were used for the analysis of Hair JF (2010) [8] Structural Equation Modeling (SEM). To determine the minimum sample size, i.e., latent variables < 7 variables, and each latent variable was measured from observable variables < 3. Variables (under-identified latent variables) have a minimum sample size of 300 individuals. Therefore, this study estimated the sample size requirement of at least 300 subjects. To deal with missing data exceeding 15% or more than 45 people, there were different conditions so a sample size of 350 people was determined. After that, a simple random sampling was performed by using a computer program to write a command to randomly pick the data from the samples from 350 people [8] .

5.2 Research tools

The data collection tools of this study were questionnaires consisting of 9 questions about general information, 14 questions about intention to perform, 14 questions about perceived behavioral control, 28 questions about self-efficacy to diet, and 19 questions about dietary behavior to control blood glucose levels.

5.3 Quality testing

The instruments used in the research were examined for the validity of the content by 5 experts. The intention to perform a behavior questionnaire, the perceived behavioral control questionnaire, the self-efficacy questionnaire, and the dietary behavior for glycemic control questionnaire received the IOC (Index of item Objective Congruence) of 0.6 – 1.0 and the coefficient of alpha Cronbach was calculated. The confidence values were .94, .94, .97, and .89 respectively.

5.4 Protecting the rights of informants

This research has been certified in human research ethics of Pathum Thani Hospital, Pathum Thani 0032.203.3/22159 and Kasetsart University COA63/034. Regarding the protection of information providers' rights, the researcher explained the research objectives, the right to answer or to not answer any questions, the right to terminate cooperation, and confidentiality to not immediately disclose confidential information or information that could damage and destroy raw data upon completion of the data analysis. Once the informant was willing to participate in the research, a consent form was signed.

5.5 Data collection

1. Submit research ethics in humans at Pathum Thani Hospital and Kasetsart University.

2. Request a certificate from the Dean of Faculty of Education, Kasetsart University and Director of Pathum Thani Hospital, Pathum Thani Province to clarify the purpose of collecting information.

3. Call on the sample and ask for cooperation in data collection.

4. Verify completeness of data for the incomplete part, ask the sample group to complete the answer.

Table 1. Parameter values, weight composition of variables in a causal relationship model of dietary behavior for glycemic control (n = 350).

Variable	Element weight				
	E	**Std, Coefficient (β)**	**SE**	**t**	**R2**
Intention to perform the behavior (INT)					
1. behavioral intention	1.054	0.922*	0.035	29.114	0.875
2. dietary planning	1.000	0.930*			0.824
Perceived behavior control (PBC)					
1. beliefs about factors affecting behavior	1.058	0.945*	0.033	32.124	0.894
2. perception of control	1.000	0.923*			0.852
Self-efficacy (SE)					
1. perceived ability to perform	1.033	0.952*	0.035	29.087	0.906
2. expectation of good results of practice	1.000	0.917*			0.840
Dietary behavior to control blood sugar levels (DIET)					
1. eating food in the right amount of nutrients	1.000	0.907*	0.043	11.929	0.824
2. choosing the right food	0.510	0.630*			0.420
Hemoglobin A1c (HbA1c)					
A1C: Hemoglobin A1c	-0.306	-0.909*	0.012	-24.884	0.827

*Statistically significant at the level .05

5.6 Data analysis

1. Preliminary analysis of data using a ready-made statistical program consisting of frequency, percentage, mean, and standard deviation.

2. Examination of the causal relationship structure of food consumption behavior for glycemic control in type 2 diabetic patients analyzed by using AMOS software program with Structural Equation Modeling (SEM) method.

6. Results

The general characteristics of the sample were 30.60% male and 69.40% female, with a mean age of 52.83 (SD=5.98). Most had a body mass index of 23.1-29.9%. 50% had the highest education at the primary school level. 54.60% had an average income of less than 10,000 baht per month. 41.40% of the sample being diabetic for 4-6 years, 30.60% taking tablet drugs to treat diabetes, 98.9% being with diabetes complications, and 16.0% having the mean level of glycated hemoglobin (HbA1c) at 8.5. For the intention to perform the behavior, the perceived behavioral control, self-efficacy and dietary behavior to control blood sugar levels, most were at the moderate level of 55.40, 52.90, 45.40 and 47.10% respectively.

Regarding method of parameter estimation, the composition weight of related variables in the causal relationship model of dietary behavior for glycemic control in type 2 diabetes patients was found. The intention to perform the behavior (INT) consist of behavioral intention (β = 0.922, p< .05) and dietary planning (β = 0.930, p< .05). The perceived behavioral control (PBC) include beliefs about factors affecting behavior (β = 0.945, p< .05) and perception of control (β = 0.923, p< .05). The self-efficacy (SE) are made up of perceived ability to perform (β = 0.952, p< .05) and expectation of good results of practice (β = 0.917, p< .05). The dietary behavior to control blood sugar levels (DIET) are composed of eating food with the right amount of nutrients (β = 0.907, p< .05) and choosing the right food (β = 0.630, p< .05). Finally, the accumulated sugar levels in the blood (HbA1c) comprises of accumulated sugar in the blood (β = −0.909, p< .05) (Table 1).

Through the analysis of the linear structural relationships, the causality model of consumer behavior is determined. It was discovered that the control of blood glucose levels in type 2 diabetic patients showed the absolute fit index of χ^2 = 4.842, df = 7, p-value = 0.679, RMR= 0.001, RMSEA = 0.001, GFI = 0.997. The incremental fit index showed NFI = 0.999, TLI = 1.003, CFI= 1.000, and parsimony fit index indicated that AGFI = 0.980, PNFI = 0.194. χ^2/df = 0.691. The consistency index of the model shows that all the results pass the criteria of the absolute fit index, incremental index, and parsimony fit index, which means that the causal relationship model of glycemic control and dietary behavior in patients with diabetes mellitus harmonies with empiricism and matriarchy. The effects of variables in the model are shown in Table 2.

When considering the model elements from direct and indirect variables affecting dietary behavior for glycemic control and blood glucose levels in patients with type 2 diabetes, it was concluded that the causal structure model was able to co-describe dietary behaviors for glycemic control affecting the glycemic index by 83% with a direct negative influence on the level of glucose in the blood, which was dietary behavior to control blood sugar levels (β = −0.91, p< .05). The perceived behavior control, self-efficacy, and intention to perform the behavior had a direct positive influence on food consumption behavior for glycemic control (β = 0.55,p< .05; β = 0.50,p< .05; β = 0.31,p< .05, respectively), and variables that indirectly influence food consumption behavior to control blood sugar levels through the variable of intention to perform were the self-efficacy to diet (β = 0.27,p< .05) and perceived behavioral control (β = 0.30,p< .05) (Table 2). Therefore, the causal

Table 2. Statistical values of the influence analysis of variables and the conformity index in the causal model of dietary behavior for glycemic control in patients with type 2 diabetes mellitus.

Variable	INT			DIET			HbA1C		
	DE	IE	TE	DE	IE	TE	DE	IE	TE
SE	0.88*	-	0.88*	0.50*	0.27*	0.77*	-	-0.70*	-0.70*
PBC	0.97*	-	0.97*	0.55*	0.30*	0.85*	-	-0.78*	-0.78*
INT	-	-	-	0.31*	-	0.31*	-	-0.28*	-0.28*
DIET	-	-	-	-	-	-	-0.91*	-	-0.91*

χ^2 = 4.842, df = 7, p-value = 0.679, SRMR= 0.001, RMSEA = 0.001 , GFI = 0.997, NFI = 0.999 ,TLI = 1.003, CFI = 1.000, AGFI = 0.980, PNFI = 0.194, χ^2/ df = 0.691

*Statistically significant at the level .05

Note.

PBC = Perceived behavior control

SE = Self-efficacy to diet

INT = Intention to perform the behavior

DIET = Dietary behavior to control blood sugar levels

HbA1C = Accumulated sugar levels in the blood

DE = Direct effect

IE = Indirect effect

TE = Total effect

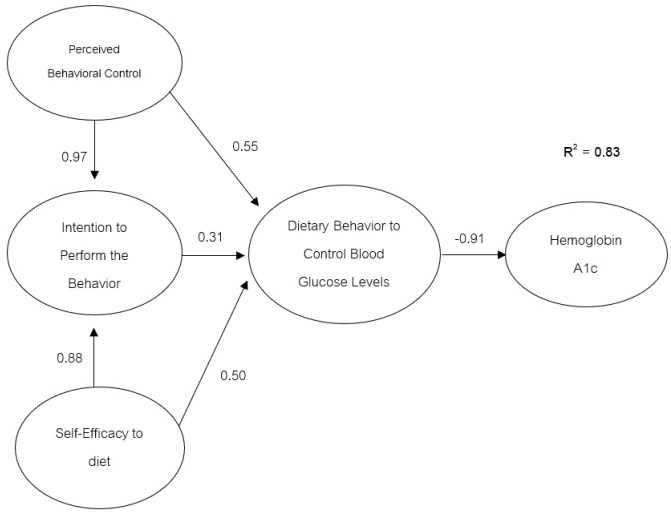

Figure 2: A causal model of dietary behavior for glycemic control in type 2 diabetes patients.

relationship structure model of dietary behavior for glycemic control in patients with type 2 diabetes was harmonized with empirical data and could theoretically explain the relationship between the variables. This is in accordance with the research hypothesis (Figure 2).

7. Conclusions and Discussions

The causal relationship structure model of dietary behavior for glycemic control in patients with type 2 diabetes was harmonized with empirical data and can contribute to explaining food consumption behaviors to control blood sugar levels affecting blood sugar levels by 83%. Dietary behaviors that control blood sugar levels have a direct negative influence on blood sugar levels. Consistent with previous studies, it was found that dietary behavior had a negative influence on blood sugar levels in patients with type 2 diabetes and had the best hypoglycemic effect, causing the absorption of glucose in the small intestine into the bloodstream [3]. The body then absorbs the sugar in the bloodstream for energy. If diabetic patients have dietary habits that are not suitable for the disease, such as consuming more than the amount of energy they should receive per day or high-energy foods; it will cause the body to secrete insulin not enough for sugar from food, resulting in hyperglycemia. If diabetic patients have proper dietary habits, this will result in lower blood sugar levels [9].

For Intention to perform the behavior (INT), there was a positive direct influence on dietary behaviors for glycemic control. Consistent with past studies [6, 10], it was found that the intention to practice has a direct positive influence on dieting behavior with serious planning and goal setting. As a result, patients should have strict dietary habits to control blood sugar levels. This is consistent with Ajzen's concept of Planned Behavioral Theory of Behavior, which stated that a person's health behaviors are formed as a result of the intention to commit that behavior and it will vary more or less depending on the intention and planning in practice.

For Perceived Behavior Control (PBC), there was also a direct positive influence on dietary habits for glycemic control and action intentions. Consistent with previous studies [6], it was found that cognitive behavioral control had a positive direct influence on food consumption behavior and has an indirect effect on food consumption behavior. Through the intention to practice [10], it is explained that when diabetic patients have the perception of behavior control, it will result in the patients

following strict dietary habits to control blood sugar levels, which will affect the intention to practice. This is proportional to beliefs about control beliefs and the level of ability to control behaviors when given the behavioral factors (perceive power) [6].

For the last variable, Self-Efficacy (SE) was also directly positively influenced dietary behaviors for glycemic control and action intentions. Consistent with the previous study (3, 7), it was found that the perceived ability to practice and the expectation of good results of practice directly influenced food consumption behavior and has an indirect effect on food consumption behavior. The intention to practice explains that the relationship between self-efficacy and the expectation of the outcome of the practice will influence the decision-making and the importance of practice. When a person has an awareness of his or her abilities with high expectations of good results from that practice, it will lead to satisfaction and can perform that behavior effectively [7].

Summary of perceived behavior control, self-efficacy and intention to perform daily dietary behavior to control blood sugar levels, affecting blood sugar levels in patients with type 2 diabetes.

8. Recommendations

8.1 Recommendations from research

1. Based on the research findings, the causal component of dietary behavior for glycemic control was identified. Therefore, a program corresponding to the causal component for dietary behavior modification affecting glycemic control should be established for the blood of a patient with type 2 diabetes.

8.2 Suggestions for further research

1. Development of a dietary behavior modification model for glycemic control in patients with type 2 diabetes by using the causal elements of behavior as inputs in the model development.

2. Development of health promotion and health education programs by applying a health education strategy consistent with the causal component of dietary behavior for glycemic control in modifying dietary behavior of type 2 diabetic patients.

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