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Original Article

Protection motivation theory to predict intention of healthy eating and sufficient physical activity to prevent Diabetes Mellitus in Thai population: A path analysis

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A B S T R A C T

Background and aims: Diabetes mellitus is a global health problem causing premature death and economic burden. The study aimed to investigate an application of the protection motivation theory (PMT) model to explain the intention of healthy eating behaviors and physical activity among healthy Thais.
Methods: This study was a part of a large case control focused only on the control group without non-communicable diseases. Nine hundred ninety-seven subjects were drawn from eleven provinces of Thailand. A self-administered questionnaire was constructed based on the PMT model to gather information on predictive factors on eating behaviors and physical activity. Path analysis was used to determine whether the empirical data fit the PMT structure as well as to assess the strength of association among PMT constructed factors predicting behavioral intention.
Results: The findings demonstrated that empirical data of eating behaviors (CMIN $\chi 2$ p-value = 0.462; CMIN/df = 0.901; NFI = 0.997; CFI = 1; RMSEA <0.001) and physical activity (CMIN $\chi 2$ p-value = 0.053; CMIN/df = 2.187; NFI = 0.987; CFI = 0.993; RMSEA = 0.035) fit the PMT. The strongest predictive factor of behavioral intention on eating behaviors was response efficacy ($\beta = 0.146$), while self-efficacy was found to be the strongest factor for physical activity ($\beta = 0.11$). Knowledge had the only indirect effect on behavior intention through perceived susceptibility and perceived severity.
Conclusion: In conclusion, information on susceptibility and severity should be incorporated in intervention strategies to enhance response efficacy and self-efficacy to prevent diabetes.

1. Introduction

Diabetes mellitus (DM) is a worldwide health problem. The World Health Organization (WHO) has estimated that more than 450 million people had been diagnosed with DM, and most were adults living in low and middle income countries [1]. In Thailand, the morbidity of DM has steadily risen over the last three years from 1292/100,000 community to 1439/100,000 [2]. However, the mortality of diabetes remained unchanged around 22% between 2016 and 2018 [2]. (see Figs. 1 and 2)

Unsuccessful glycemic control resulting from poor self-care behaviors has proven to develop severe complications such as retinopathy, nephropathy and neuropathy cardiovascular diseases [3]. Moreover, it negatively impacts employment, reduced work productivity and increased economic burden of medical costs [4].

Self-care behavior is a human regulatory function performed by individuals to maintain a healthy life. They can be learned, shared and practiced to develop skills to manage themselves effectively

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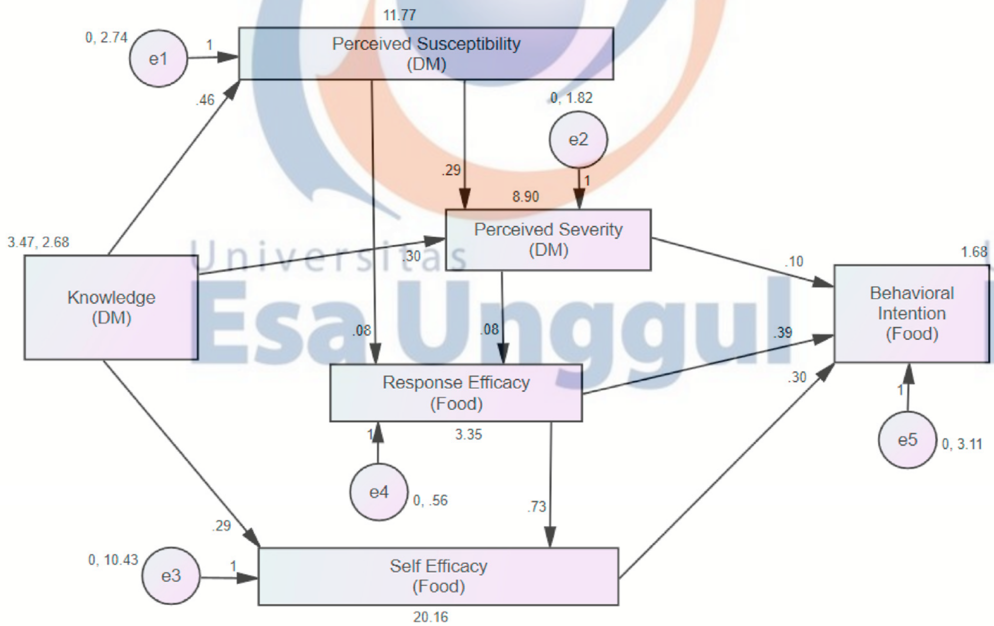

Fig. 1. Standardized coefficient of PMT adjusted model on eating behavioral intention.

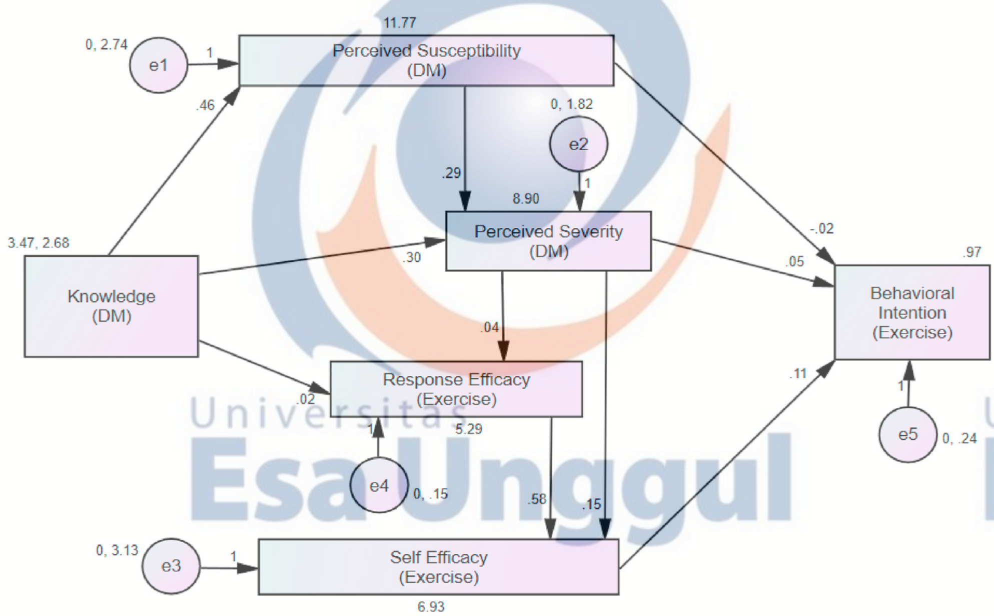

Fig. 2. Standardized coefficient of PMT adjusted model on PA behavioral intention.

[5]. Concerning self-care behaviors, healthy diet and sufficient physical activity played central roles to prevent developing diabetes [6,7]. Moreover, it aimed to avoid the risk of progression from impaired glucose tolerance and controlled weight and metabolic markers [8–10]. This strategy also substantially improved insulin sensitivity and glycemic control and increased cardiovascular fitness and muscle strength [11,12]. American Diabetes Association confirmed the most challenging part of managing diabetes was to control healthy diet by following a meal plan and strengthening physical activity to meet the recommended physical activity guidelines [11].

Several barriers were associated with inconsistently engaging in healthy eating habits and sufficient physical activity to achieve daily life activity demands [13]. Related findings have indicated a lack of knowledge and low self-efficacy [14] were fundamental issues related to poor glycemic control among individuals with T2DM. Previous health education programs showed improved self-efficacy and self-care behaviors among patients with DM after implementation. Adequate knowledge of managing their daily life activities was associated with self-efficacy to perform self-care practice [15,16]. Bandura's Social Cognitive Theory [17] explains the relationship between social-cognitive factors, for example, knowledge, perception and individual motivation to improve their behaviors. This theory emphasizes self-efficacy as an individual's perception of his capacity to produce specific performance attainment. Self-efficacy reflects confidence in one's ability to control one's behavior and has proved a decisive factor in determining human behavioral change. Moreover, ineffective coping responses concerning diabetes risk and inappropriate beliefs concerning diabetes regimen were also considered barriers to diabetes self-management [3]. Another reason for unsuccessful glycemic control comprised limited theory-driven practical programs on healthy lifestyle modification [18]. These theory-driven programs are essential to support intervention activities to promote behavioral change among individuals with chronic diseases and strengthen healthy practices. However, translation of theory into practice should be empirically examined before implementing programs.

The protection motivation theory (PMT) is an influential theory that attempts to promote behavioral change, improve coping appraisal and cognitive belief and promote self-efficacy on lifestyle modification for healthy behaviors [19]. The PMT demonstrates the relationship between adaptive and maladaptive responses to health threats and the intention to perform adaptive behavior. Maladaptive responses are unhealthy behaviors that place an individual at risk and develop consequences of the health problem, for example, eating highly sweetened food and the risk of DM. On the other hand, adaptive responses are the ways that an individual can perform appropriate behaviors to reduce health threats. Adaptive and maladaptive coping to health risks can be demonstrated through two appearance processes known as threat and coping appraisal. Threat appraisal comprises perceived susceptibility or the chance of contracting the disease and perceived severity concerning the seriousness of fatal or long term impacts. Coping appraisal includes response efficacy as an individual's expectancy to follow recommendations for action, and self-efficacy as the belief of an individual's ability to take action successfully [20]. Protection motivation has been proved as the most influential factor in behavioral change, especially in supporting patients with diabetes to perform healthy eating behaviors and active physical activity [21,22].

PMT has been applied to develop intervention strategies to promote healthy eating and physical activity in several studies. The positive effects of using PMT to predict behavioral changes among patients with chronic-illness [23,24]. On the contrary, one study mentioned no positive impact of motivation on students' physical activity intention [25].

Even though healthy eating and sufficient physical activity are crucial strategies to prevent the progression of DM, a healthy lifestyle program to enhance self-management was successful only among Thai patients with T2DM [26]. At the same time, it had limited success among the general Thai population. This unsuccessful case was due to poor perception (vulnerability and severity), lack of motivation and lack of knowledge on healthy lifestyle behaviors [27]. Our case control study to identify risk factors of noncommunicable diseases (NCDs) among Thais found that those free from NCDs (control group) performed sufficient physical activity at 13.7%. In contrast, only 10.2% was found among patients with diabetes. It was also shown from healthy eating habits, most of the participants in both case and control groups consumed highly sweetened (59.35%) and fatty foods (65.65%) [28].

Nevertheless, limited studies have applied PMT to predict the intention of both healthy eating behaviors and physical activity simultaneously. Moreover, no related findings have proven the relationship of knowledge, threat appraisal and coping appraisal with the intention to manage a healthy lifestyle to prevent diabetes in the Thai population. Therefore, this study aimed to apply PMT to explain the pathway relationship of influencing factors to perform healthy eating behaviors and physical activity among healthy Thais. Findings from this study would be beneficial to adjust or tailor intervention activities to prevent DM in the Thai community in the future.

1.1. Study hypotheses

Based on PMT, the pathway relationship of influencing factors on intention to perform healthy eating behaviors and physical activity comprising knowledge, perceived susceptibility, perceived severity, response efficacy and self-efficacy was examined. The main hypotheses were [1]: DM knowledge has a direct effect on both perceived susceptibility and perceived severity of DM, response efficacy, and self-efficacy to change behaviors and has a direct and indirect impact on behavioral intention [2]; perceived susceptibility and perceived severity of DM has an immediate effect on both response efficacy and self-efficacy and also has both direct and indirect impacts on behavioral intention and [3] perceived susceptibility to DM, perceived severity of DM, self-efficacy and response efficacy has an immediate effect on behavioral intention.

2. Method

2.1. Sample and sampling technique

This present study is a part of a case control study on NCDs risk factors in a Thai population. Based on the sample size calculation of Daniel for one proportion study [29], the proportion of regular physical activity in the Thai population in 2014 was 26% [30]. Using a 95% confidence level and a 5% absolute error for one sample test as a proportion, the calculated sample size required for this study was at least 296 cases. We recruited the total number in a control group absent from NCDs ($n = 997$), which was more significant than the total number of the estimated subjects as our target sample to examine the path analysis of behavioral intention on healthy eating behaviors and physical activity to prevent DM. The subjects were drawn from the same communities of NCDs cases under the catchment areas of 11 regional and provincial hospitals located in 6 regions of Thailand. These regions comprised northern, northeastern, western, eastern, southern, and central Thailand.

Stratified sampling by six regions was performed to select the subjects based on the inclusion criteria. The criteria included 1) Thai, aged 35 years old and over, 2) residing in the same community under the catchment area of each hospital where the NCDs cases were selected, 3) free from six NCDs related to lifestyle risk factors defined by WHO including DM, cardiovascular disease, stroke, chronic obstructive pulmonary disease, colorectal cancer and lung cancer and 4) willing to participate in this study. The period of study was between June 2015 and June 2018.

2.2. Instruments for data collection

Socio-demographic factors: Sixteen questions were used to explore information on age, sex, residence, income, occupation, health insurance, use of health services during the last one year and family history of NCDs.

Current eating behaviors: Two sets of a questionnaire were used to collect healthy eating behaviors. The first questionnaire comprised 15 questions regarding flavors concerning eating behaviors and the frequency of eating sweetened, fatty and salty food in one month with a 4-point rating scale using always-often-sometimes-never for each eating behavior. Total eating behaviors could be classified in two groups as often and sometimes and never do. The food frequency questionnaire (FFQ) [31] was also applied to determine types and amount of food consumed by recalling within one month the three types as five main groups of food: risk food such as high fat, high starch, and high sugar, protective food such as high fibers, high mineral and vitamin. In all, 73 items of 7 categories involved answers from never to less than one time/month, 2 to 3 times/month, 1 to 3 times/week, 4 to 6 times/week, once daily, and more than once/daily.

Current physical activity: The general physical activity questionnaire (GPAQ)-short form version of WHO translated to Thai by Visuttipanich V [32] was applied to explore information on physical activity. The physical activity level could be calculated using metabolic equivalent tasks (METs), defined as the amount of oxygen consumed while exercising rather than sitting at rest and is equal to 3.5 ml O_2 per kg body weight x min [33]. The three components of the physical activity questionnaire comprised questions 1 to 7 on work activity; questions 8 to 11 on daily life and transportation; questions 12 to 18 on recreation activity; and question 19 on sedentary hours spend daily. Total METs could be classified as low, moderate and high levels of physical activity. In summary, the METs were summarized as sufficient and insufficient physical activity.

PMT questionnaire. The PMT questionnaire was constructed based on the PMT of Rogers [34]. The four components comprised Part 1 with 25 items of true or false items on knowledge toward cause, symptoms, and diagnosis of NCDs with five items focused on diabetes. Part 2 with 50 items comprised threat appraisal toward NCDs prevention using a 5-point Likert scale: strongly agree, agree, uncertain, disagree and strongly disagree. Among these, questions 1 to 5 focused on perceived susceptibility to diabetes, while questions 6 to 10 emphasized the perceived severity of diabetes. Part 3 with 47 items concerned coping appraisal toward NCDs prevention using a 5-point Likert scale: strongly agree, agree, uncertain, disagree and strongly disagree. Among these questions, 35 items focused on self-efficacy and 12 questions concerned response efficacy. Regarding self-efficacy items, questions 1 to 10 focused on healthy eating behaviors with positive statements on items numbered 1, 2, 4, 5, 6, 7, and 8, respectively. The rest were negative statements.

Additionally, questions 21 to 25 focused on physical activity with positive statements on items numbered 21, 22, and 24, and the rest were negative statements. In all, 12 questions concerned response efficacy. The 5-point Likert scale ranged from strongly agree, agree, uncertain, disagree and strongly disagree. All were positive statements with questions 1 to 2 concerning healthy eating behaviors and items 7 and 8 on sufficient physical activity. Part 4 consisted of ten questions concerning intention to practice healthy behaviors. The 3-point rating scales included confident to perform, unsure, and unconfident to perform.

2.3. Validity and reliability test of instruments

Five experts determined the content validity in NCDs and lifestyle modification. Mean item content validity index (CVI) of each part were as follows: knowledge = 0.947, threat appraisal = 1.000, coping appraisal = 0.915, and intention to practice = 0.900 [35].

The difficulty of knowledge items, and difficulty index were examined. The difficulty index of diabetic knowledge ranged between 0.54 and 0.80, indicating moderate difficulty and ability to use [36]. The reliability test of diabetic knowledge considered using Kuder-Richardson 20 (KR-20) was 0.793. Alpha's coefficient of Cronbach performed the reliability test of threat and coping appraisal on DM. The findings revealed threat appraisal on DM was 0.706 while coping appraisal was 0.805 for response efficacy and 0.799 for self-efficacy. The reliability test of intention to practice was 0.729 [35].

2.4. Statistical analysis

Path analysis was performed responding to the following objectives: 1) examine the pathway of the predictive relationship among the PMT variables constructed based on the PMT model and 2) compare the variation of the theoretical constructed model with the causal structure found. Path analysis is suitable and was suggested by different researchers [19] to test the social cognitive model's causal relationship.

2.5. Model fit

The AMOS Program was used to estimate the path analysis using maximum likelihood estimations of each parameter in the hypothetical model. Each significant parameter in the path analysis was determined using a standardized regression weight estimate (β) of the adjusted model fit with the hypothetical model. Test for the goodness of fit of the pathways on influencing factors toward intention to practice healthy eating behaviors and physical activity are summarized in Table 1:

2.6. Ethics consideration

The committee of the Ethics Review Board in all 11 provincial/regional hospitals approved this research before collecting data. Informed consent was obtained from each participant willing to participate in this study.

3. Results

3.1. Demographic data

Among the 997 subjects in the control group, 70% were females. The mean average was 48.13 ± 9.51 years old, with 68% aged from 40 to 59 years old. More than one half (67%) were married. Concerning educational level, nearly 40% completed bachelor level and above. One half were government employees (52%) followed by private employees (13%) and laborers (13%). Slightly more than one third (39%) were under the civil servant under the medical benefit scheme, and one third (35%) were under the social security scheme. The mean average monthly family was 41,671 ± 56,631 THB. One fourth (24%) had a family history of T2DM (Table 2).

3.2. Descriptive statistics and correlation matrix

Table 3 explains the correlation matrix of predictive factors with healthy eating behaviors and physical activity. The findings showed that all PMT variables were significantly positively correlated with behavior intention to change eating behaviors. The first two strongest correlations were found among self-efficacy concerning healthy eating behaviors (r = 0.429) and perceived susceptibility of diabetes (r = 0.232). Regarding physical activity, the results also found the strongest correlation was self-efficacy (r = 0.0.223), while the second rank was perceived severity of diabetes (r = 0.098).

Model testing of the structural prediction of PMT.

Table 4 indicates the model fit between the structural model from empirical data and theoretical model for both healthy eating behaviors (CMIN χ^2 p-value = 0.462; CMIN/df = 0.901; NFI = 0.997; CFI = 1; RMSEA <0.001), and physical activity (CMIN χ^2 p-value = 0.053; CMIN/df = 2.187; NFI = 0.987; CFI = 0.993; RMSEA = 0.035).

Table 5 indicates the direct, indirect and total standardized effects of predictive factors on behavioral intention. Findings demonstrated that both direct and indirect influence on intention to change eating behaviors consisted of response efficacy (β = 0.146; β = 0.082) and perceived severity (β = 0.078; β = 0.039). Self-efficacy had only a direct effect on the intention to change eating behaviors (β = 0.048). At the same time, DM knowledge (β = 0.138) and perceived susceptibility (β = 0.079) only exhibited

Table 1
Statistical test for goodness of fit between empirical data and hypothetical model[a].

Statistics	Explanation	Interpretation
Number of parameters (NPAR)	Total number of an estimated parameter from empirical data	Less than a hypothetical model (Full model)
Chi-square (CMIN $\chi 2$)	To test whether empirical data absolute fit the hypothetical model or not	p-value of CMIN $\chi 2 > 0.05$
Relative Chi-square (CMIN $\chi 2$/df)	The proportion of Chi-square and degree of freedom varied by the number of samples	<2.0 indicated model fit
Comparative fit index (CFI)	Comparative fit index of a constructed and hypothetical model	≥0.9 indicated model fit
Normed fit index (NFI)	Comparative fit index of a constructed and hypothetical model	≥0.9 indicated model fit
Root mean square error of approximation (RMSEA)	Degree of variance to estimate parameter in the model	<0.05 indicated model fit

[a] Adapted from Hooper D, Coughlan J and Mullen MR. Structural Equation Modeling: Guidelines for Determining Model Fit [37].

Table 2
Demographic data of the respondents (n = 997).

Demographic data	n	%
Sex		
Male	300	30.1
Female	697	69.9
Age group (years)		
<40	106	10.6
40–59	675	67.7
≥60	216	21.7
$\bar{X} \pm SD$ = 48.13 ± 9.51		
Marital status		
Single	252	25.3
Married	670	67.2
Divorced/Separate/Widow	75	7.5
Educational level		
Primary school or less	229	23.0
Secondary school	110	11.1
High school/Vocational school	272	27.4
Bachelor degree and over	383	38.5
Occupation		
Unemployed/Homemakers	79	8.3
Laborers	122	12.8
Agriculturalists	74	7.7
Private employees	122	12.8
Small business entrepreneurs/Traders	63	6.6
Government employees	496	51.9
Health insurance scheme		
Universal coverage (UC)	253	25.5
Social security scheme (SSS)	351	35.3
Civil servant medical benefit scheme (CSMBS)	390	39.2
Family income (THB/month) n = 427		
<10,000	46	10.8
10,000–19,999	83	19.4
20,000–29,999	70	16.4
30,000–49,999	142	33.3
≥50,000	86	20.1
$\bar{X} \pm SD$ = 41,671.73 ± 56,631.78 Min = 1000 Max = 300,000		
History of DM in family		
Yes	239	24.0
No	758	76.0

an indirect effect on intention towards healthy eating behaviors. Together, all factors could predict the intention to change eating behaviors among healthy control to prevent diabetes at 30% (adjusted $R^2 = 29.9\%$).

When considering intention to change physical activity, only two predictors had both direct and indirect effects on intention to improve physical activity comprising perceived susceptibility ($\beta = -0.02$; $\beta = 0.29$) and perceived severity ($\beta = 0.05$; $\beta = 0.15$), while only self-efficacy had a direct effect ($\beta = 0.11$). DM knowledge ($\beta = 0.78$) and response efficacy ($\beta = 0.58$) had an indirect impact on intention to change physical activity. Together, all factors could predict the intention to change physical activity among healthy controls to prevent diabetes at 17% (adjusted $R^2 = 16.9\%$).

4. Discussion

This study examined both direct and indirect effects of predictive factors on behavioral intention to change unhealthy eating behaviors and physical activity habits. The PMT model is commonly used as a social cognition model to predict health behaviors. It explained behavioral changes depending upon threat and coping appraisal [23]. Results indicated that perceived susceptibility indirectly affected eating behavior's intention while directly and indirectly affecting physical activity. Regarding perceived severity, results indicated both direct and indirect effects were found concerning the two behaviors. Self-efficacy was considered to have only a direct impact on intention toward both unhealthy behaviors. However, response efficacy was found to directly affect eating behaviors and had an indirect effect through self-efficacy. Self-efficacy was an essential factor contributing to changing unhealthy behaviors [38,39]. It could be explained that self-efficacy acted as a motivating factor to enhance self-confidence to change behaviors. People exhibiting high self-efficacy tended to have high intentions to change their behaviors. The result was consistent with a related study that confirmed that self-efficacy had a positive effect on behavioral intention [40].

The PMT could explain intention to change behaviors through threat and coping appraisals. The PMT recommended response efficacy could eliminate the threat and enhance the belief of one's ability to perform an appropriate behavior [41,42]. PMT demonstrated key social-cognitive determinants on health behaviors in that knowledge from self-learning and sharing experiences with others or learning from a role model could enhance an understanding of the benefits of changing their health behaviors in an optimum way. It could be concluded that sufficient knowledge could increase response efficacy to perform one's ability to change unhealthy behaviors [43,44]. This finding was consistent with a related study [45] reporting that perceived susceptibility and self-efficacy directly affected behavioral intention to perform physical exercise. Compared with prior studies conducted among patients with T2DM, perceived susceptibility was no direct effect on behavioral intention to perform physical activity [19,23]. This may have been because patients with T2DM no longer perceived susceptibility of the disease. Another study found that only self-efficacy directly affected behavioral intention to perform physical exercise [21,46].

Regarding intention to change unhealthy eating behaviors, the present study found three predictive factors that directly affected behavior intention: perceived severity, response efficacy and self-efficacy. Three related studies also found self-efficacy, directly impacted behavioral intention to change eating habits [23–25]. Two studies demonstrated a direct effect of response efficacy on behavioral intention [23,24]. Another study by Mogendi [25] confirmed that knowledge indirectly affected behavioral intention, while perceived susceptibility and perceived severity directly

Table 3
Descriptive statistics and Pearson's correlation matrix of predictive factors to healthy eating behaviors and physical activity.

Variables	$\overline{X}$±SD	1	2	3	4	5	6
Healthy eating behavior							
1. DM Knowledge	3.72 ± 1.64	1					
2. Perceived susceptibility	13.99 ± 1.68	0.377	1				
3. Perceived severity	14.32 ± 1.37	0.446	0.607	1			
4. Response efficacy	5.52 ± 0.78	0.102	0.204	0.196	1		
5. Self-efficacy	26.01 ± 3.15	0.104	0.203	0.202	0.25	1	
6. Behavioral intention	13.96 ± 1.58	0.1	0.232	0.177	0.207	0.429	1
Physical activity							
1. DM Knowledge	3.72 ± 1.64	1					
2. Perceived susceptibility	13.99 ± 1.68	0.377	1				
3. Perceived severity	14.32 ± 1.37	0.446	0.607	1			
4. Response efficacy	5.94 ± 0.32	0.063	0.086	0.142	1		
5. Self-efficacy	12.21 ± 1.84	0.142	0.061	0.076	0.125	1	
6. Behavioral intention	2.83 ± 0.43	0.093	0.098	0.157	0.046	0.223	1

[a]Significant at p-value <0.05.
[b]Significant at p-value <0.001.

Table 4
Goodness of fit indices for the predictors of behavioral intention using PMT model.

Variable	N	NPAR	χ2	df	χ2/df	p	CFI	NFI	RMSEA
Eating behavior	997	23	4.142	4	1.035	0.387	1	0.996	0.006
Physical activity	997	20	8.452	7	1.207	0.294	0.997	0.989	0.015

Note: N = total sample; NPAR = number of total parameters in the model; χ2 = chi-square; CFI = comparative fit index; NFI = normed fit index; RMSEA = root mean square error of approximation.
Direct, indirect, and total standardized effects of predictive factors on behavioral intention.

Table 5
Direct, indirect and total standardized effects of predictive factors on behavioral intention.

Predictive factor	Standardized effect			Adjusted R^2 (%)
	Direct	Indirect	Total	
Eating Behavior				
1. DM Knowledge	0	0.138	0.138	29.9%
2. Perceived susceptibility	0	0.079	0.079	
3. Perceived severity	0.078	0.039	0.117	
4. Response efficacy	0.146	0.082	0.229	
5. Self-efficacy	0.048	0	0.048	
Physical activity				
1. DM Knowledge	0	0.78	0.78	16.9%
2. Perceived susceptibility	−0.02	0.29	0.27	
3. Perceived severity	0.05	0.15	0.2	
4. Response efficacy	0	0.58	0.58	
5. Self-efficacy	0.11	0	0.11	

impacted behavioral intention.

This present research constitutes the first study conducted using PMT to examine the predictors of healthy eating habits and physical activity among the Thai population. An application of PMT in a clinical context was of significant importance to the current literature. This study also applied path analysis to test the significance of the explanation pathways of behavioral intention on healthy eating habit and sufficient physical activity. Both direct and indirect effects were found of social cognitive predictors including knowledge, perceived susceptibility and perceived severity of DM and response efficacy and self-efficacy to change unhealthy behaviors.

Therefore, information on healthy lifestyle behaviors to prevent NCDs should be disseminated using different mass media channels to easily access and understand enhanced health literacy in a Thai population. Stakeholders should continue to actively promote physical exercise on different occasions such as mini-marathons and aerobic exercise by involving community volunteers and younger generations as a change agent. Moreover, community mobilization concerning healthy eating behaviors and active physical exercise needs to be conducted to strengthen community health promotion activities using local resources incorporating daily activities. The District Health Board should also be a focal point on driving policy into action in every local community to maintain healthy eating habits and sufficient physical activity.

5. Conclusion

We concluded that self-efficacy had a direct effect on changing both unhealthy eating behaviors and physical activity. At the same time, response efficacy had only a direct impact on eating behavior. Knowledge had the only indirect influence on behavior intention through all four components of threat and coping appraisal. Further, information on susceptibility and severity should be incorporated in intervention strategies to prevent diabetes.

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Author contribution

Kanittha Chamroonsawasdi and Suthat Chottanapund conceived and designed the research; Kanittha Chamroonsawasdi and Oranuch Numpaisan analyzed the data; Kanittha Chamroonsawasdi and Rian Adi Pamungkas wrote and edited the manuscript; Pravich Tunyasittisundhorn and Bundit Sornpaisarn acted as supervisors.

Declaration of competing interest

We declared no conflict of interest in this study. The funding sponsor also had no role in the writing of the manuscript or the decision to publish this manuscript.

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