



Causal relationship model for maintaining exercise behavior among Thai university staff: Integration of transtheoretical model and self-determination theory

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Abstract

The transtheoretical model (TTM) and self-determination theory (SDT) are behavior modification tools that have been widely used in psychology, sports, social sciences and health promotion. However, these tools have never been integrated in the study of exercise behavior maintenance (MEB) among Thai population. The aim of this study was to integrate theoretical constructs from TTM and SDT in the prediction of physical exercise behavior of university staff in central Thailand. Four universities (2 private and 2 public) were sampled for this study. Staff ($n = 460$) within these universities participated by willful volition. Their current exercise behaviors were unraveled via psychological approach using questionnaires. Information from these questionnaires were used as input to construct a structural equation model for predicting barriers to exercise behavior maintenance (MEB). Model data analyzed using bivariate correlation provided a good fit ($\chi^2 = 110.07$, $p = .190$, $df = 98$, $GFI = 1$, $CFI = 1$, $RMSEA = 0.016$, $AIC = 106.07$) and explained 73 percent of the variation in MEB. All constructs of TTM had indirect effect on MEB except stage of change (SOC) (correlation = .94). All structural pathways were also significant and positive except for SDT, which had a weak negative correlation (-.11) with MEB. The findings showed that SOC and SDT can be used coherently in designing suitable exercises to meet the needs of the university staff while maintaining a balance with work life.

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Introduction

In modern Thai society, lack of physical exercise has been identified as one of the leading causes of non-communicable diseases (Alexandratos et al., 2012; Bellavere et al., 2018; Stern et al., 2019). In Thailand, NCDs were responsible for 399,100 (215,500 males and 183,600 females) deaths, approximately 74 percent of all deaths occurring in 2016 (World Health Organization, 2018). The increasing rate of urbanization especially within the central metropolitan regions has inadvertently spurred physical inactivity and sedentary lifestyle among the working class (Liangruenrom et al., 2019). (Angkurawaranon et al., 2014; Sallis & Owen, 1999). The working class often mention a lack of time and feelings of fatigue as reasons for not exercising. (Dans et al., 2011; Lin et al., 2012; Yiengprugsawan et al., 2011). This has raised concerns about the possible long term health implications especially on university staff within these regions. A collaborative effort between research institutions, exercise psychologists, trainers, government and non-governmental agencies is required to buttress the need for increased physical exercise, communicate its benefits as well as provide enabling environment to bolster behavior modification among vulnerable populations (Kazdin, 1981).

The terms “behavior change or behavior modification” as used interchangeably in this text refer to intervention processes targeted towards the elimination of undesired behaviors for more desirable ones. Transtheoretical model (TTM) and self-determination theory (SDT) are behavior modification tools used not only to classify a state of change but also to proffer practical steps to meet the desired change (Akin-Little & Little, 2009). The TTM comprises four components: stages of change (SOC), ten processes of change (POC), decisional balance (DB), and self-efficacy (SE) (Marcus & Simkin, 1994). The SOC categorizes individuals according to their willingness to change and the length of time they have been actively engaged in the behavior. The five SOC are pre-contemplation, contemplation, preparation, action and maintenance (Hearn, 2017). The transition from one stage to another constitutes the POC. The 10 POC includes five ‘behavioral’ and five ‘cognitive’ processes which enable individuals to progress from one SOC to another (Romain et al., 2014). The DB construct is a cognitive process that guides individual perceptions of the pros and cons of specific behavior change (Charkazi et al., 2017). The term, ‘SE’ denotes the inherent ability to overcome barriers to initiating and

maintaining a desired behavior (Hewett et al., 2018). The SDT is a meta-theory that describes how various factors (both internal and external) either foster or hinder intrinsic and extrinsic motivation (Deci & Ryan, 2013). Under this theory, behavior change is viewed as a process inspired by various motivational tools (Shilney, 2019). Reports have shown that integrating TTM and SDT helps individuals understand the need for behavior change (Hearn, 2017).

The current population survey was meant to serve three purposes: (1) to understand the exercise behavior of Thai university staff within the central metropolis; (2) to serve as an informative tool for exercise coaches, trainers, and government and non-profit agencies, including health experts, on the current exercise and potential health needs of the study population; and (3) to identify the major factors that promote or hinder physical exercise among Thai university workers in urban settlements. Therefore, the aim of this research was to integrate theoretical constructs of TTM and SDT in the promotion of health and exercise behavior of university staff in central Thailand.

Hypothesis: This study hypothesized that an integrated model comprising TTM, SDT, and motivation will be a more implicit tool for promoting exercise behavior than when used exclusively.

Methodology

Participants

Twenty subjects were required to validate each of the 23 observed variables (Schumacker & Lomax, 2004). The 460 participating staff (160 males, 300 females aged between 18 and 59 years) were selected from 4 (2 private and 2 public) universities within the central region of Thailand by multistage sampling using a cluster and simple random sampling technique. This study was conducted under the approval of Kasetsart university research ethics committee (COA No. COA62/017). All participants signed a written consent before participation. The evaluation process first involved the use of a psychological approach (in the form of questionnaires) to understand the current exercise behavior of participants.

Procedure

Each participant received questionnaires on TTM, SDT, and MEB, which were filled in and submitted by

regular post. The estimated time for completing these questionnaires was 30 minutes. The TTM consisted of four questionnaires: (1) physical activity stage algorithm (PASA); (2) physical activity processes of change questionnaire (PAPCQ); (3) physical activity self-efficacy questionnaire (PASEQ); and (4) physical activity decision balance questionnaire (PADBQ). To determine content validity, five experts in sports and exercise psychology exclusively evaluated and provided an item-objective congruence index score (IOC) for all questionnaires. An IOC score above 0.5 was considered ideal. Thirty staff from universities different from those used for this study participated in the reliability test. Reliability coefficient was determined by Cronbach's alpha method (Miller, 2010). The results of the content validity and reliability test are presented in Table 1.

The PASA assessment tool categorized each participant into a discrete SOC, thereby reducing the bias associated with clustering. Participants were given a single question with 5 response items. This questionnaire was a modification of a previously developed version by Marcus (Marcus & Simkin, 1994). Information on present exercise activities (e.g. walking, running, cycling, swimming, tennis, or any other preference) as well as the period of active exercise were obtained through a questionnaire. For each question, participants were given a list of options—such as “I have been active for more than six months” (maintenance), “less than six months” (action); “I do not exercise regularly but intend to in less than a month” (preparation); “I intend starting within the next six months” (contemplation); and “I am not active and have no intention to be within the next six months” (pre-contemplation)—to select the best one that suited their exercise behavior. The answers to these questions determined the individuals' current SOC.

The PAPCQ questionnaire contained 30 items measuring the experiential and behavioral POC. Here, the

participants recalled previous physical activities and their respective frequencies using a five-point Likert scale (from 1 = never to 5 = repeatedly).

The PASEQ, an SE assessment tool, determined participants confidence to exercise in adverse circumstances (such as bad weather, emotional condition). The questionnaire consisted of six items rated on a five-point Likert scale (from 1= not at all confident to 5 = very confident).

The PADBQ assessed participants' decisional balance. The questionnaire consisted of 10 items rated on a five-point Likert scale. The scale included two sub-scales representing the positive (Pros-five items) and negative (Cons-five items) aspects of exercise behavior. Participants were asked to indicate how important each statement was regarding their decision on whether to participate in exercise behavior. The scale was ranked from 1 = not at all important to 5 = extremely important.

The SDT was used to explain how well motivation fostered or impeded behavior modification. Participants completed a questionnaire with 28 questions about the source of their motivation. The questions were grouped into seven motivation sub-scales: (1) external regulation, (2) introjected regulation, (3) identified regulation, (4) integrated regulation, (5) intrinsic motivation to learn, (6) intrinsic motivation to accomplish tasks, and (7) intrinsic motivation to experience sensations. The response items were rated on a six-point Likert scale (from 1 = strongly disagree to 6 = strongly agree).

The maintenance of exercise behavior questionnaire (MEBQ) is a self-report assessment technique used for judging how well TTM and SDT classified a participant's exercise behavior. Using MEBQ, exercise frequency, intensity, duration, type, time, and attitude were examined. MEBQ consisted of 17 questions with five-point response items rated on a five-point Likert scale (from 1 = never to 5 = repeatedly).

Table 1 Content validity, reliability and distribution of responses to all questionnaires

Questionnaire	Validity	Reliability	Variables	Mean \pm SD	Skewness	Kurtosis	Level
MEBQ	0.88–0.95	0.96	MEB	2.80 \pm 1.07	-0.91	0.23	average
PASA	1	NE	SOC	3.52 \pm 1.21	-0.55	-0.19	good
SDT	0.88–0.91	0.81	SDT	4.66 \pm 0.73	-0.56	1.56	excellent
PASEQ	0.90–0.91	0.95	SE	2.99 \pm 0.90	0.08	0.15	average
PAPCQ	0.88–0.95	0.96	POC	3.68 \pm 0.62	-0.42	1.21	good
PADBQ	0.80–0.86	0.79	DB	3.38 \pm 0.68	0.24	0.34	good

Note: PASA = physical activity stage algorithm; PAPCQ = physical activity processes of change questionnaire; PASEQ = physical activity self-efficacy questionnaire; PADBQ = physical activity decision balance questionnaire; NE = not-estimable. Because PASA had a nominal category, reliability score could not be estimated.

Statistical analysis

Correlation between observed variables was determined based on likelihood estimation using the weighted mean response, and frequency. The SPSS® version 26.0 software (SPSS Inc. Chicago, IL) was used to determine data normality, scale reliabilities, bivariate, and intraclass correlations. With responses from the above questionnaires, a structural equation was modeled using LISREL®8.80 software (Scientific Software Inc., Lincolnwood, IL). Constructs from TTM (SOC, SE, POC, and DB), SDT, and MEB were latent variables in the structural model. Sub-components of the questionnaire (such as negative effect, excuse-making, must exercise alone, inconvenient to exercise, resistance from others, bad weather; cognitive/experiential processes, behavioral processes; positive aspects of exercise behavior, negative aspects of exercise behavior; extrinsic motivation, introjected regulation, identified regulation, integrated regulation, intrinsic motivation to learn, intrinsic motivation to accomplish tasks, intrinsic motivation to experience sensation; frequency, intensity, time/duration, for SE, POC, DB, SDT, and MEB respectively) excluding SOC were the observed variables in models. Model selection was done using the Akaike information criterion (AIC). Fit indices were determined following the criteria explained in another study (Joreskog & Sorbom, 2008). Statistical significance was set at $p < .05$.

Results

In this study, constructs from TTM, SDT and MEB were modeled using returned questionnaires from

university staff in central Thailand. Participants were grouped according to their various SOC at the time of response to the questionnaire; 34.57 percent were at preparation, 26.52 percent maintenance, 23.91 percent action, 8.5 percent contemplation and 6.52 percent pre-contemplation. The weighted mean, skewness and kurtosis for each response to the questionnaires are summarized in line with these constructs and are presented in Table 1.

Most constructs of TTM (SE, POC, DB) had an indirect effect on MEB except for SOC. While SE, POC and SDT had direct effect on SOC, DB had a direct effect on POC in the model. Also, SDT had a positive but weak correlation (0.28) with SOC; however, with MEB, the correlation was negative (-0.11). Because SOC had a direct effect and a strong positive correlation with MEB, it was used as a mediator variable for analyzing the exercise behavior of study participants. The correlation matrix for all latent variables used in this model is shown in Table 2. The relationship between constructs of TTM, SDT and MEB has been presented in Figure 1; its fit indices are shown in Table 3. The coefficients for direct, indirect and total effect of all model components are shown in Table 4.

Table 2 Pearson correlation coefficient of model constructs

	MEB	SOC	SDT	SE	POC	DB
MEB	1					
SOC	0.435	1				
SDT	0.539	0.331	1			
SE	0.738	0.479	0.540	1		
POC	0.637	0.472	0.640	0.666	1	
DB	0.432	0.109	0.547	0.368	0.440	1

Note: ** $p < .01$, * $p < .05$.

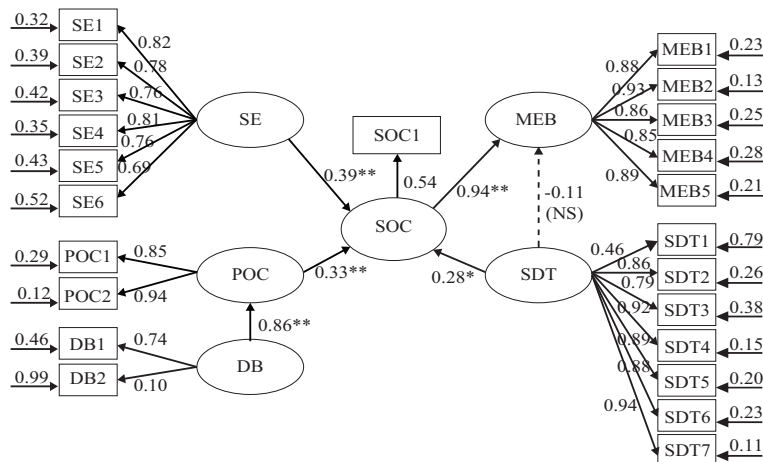


Figure 1 Structural equation model showing the association between all terms of TTM, SDT and MEB construct

Table 3 Fit index criteria used for validating structural equation model in the current study

Fit indices	Criteria	Result
Chi-square (χ^2)	-	110.07
Degree of freedom (df)	-	98
Relative chi-square (χ^2/df)	< 2.00	1.123
Probability value (<i>p</i> value)	> 0.05	0.190
Goodness of fit index (GFI)	> 0.90	0.98
Adjusted goodness of fit index (AGFI)	> 0.90	0.94
Root mean square residual (RMR)	< 0.05	0.040
Standardized root mean square residual (SRMR)	< 0.05	0.037
Root mean square error of approximation (RMSEA)	< 0.05	0.016
Comparative fit index (CFI)	CFI > 0.90	1.00
Normed Fit Index (NFI)	NFI > 0.90	1.00
Non-Normed Fit Index (NNFI)	NNFI > 0.90	1.00
Akaike information criterion (AIC)	-	106.07

Table 4 Standard scores of analyses showing the correlation coefficients of model components direct, indirect, and total effect for all components of the structural equation models

Causal variable	Effect								
	POC			SOC			MEB		
	DE	IE	TE	DE	IE	TE	DE	IE	TE
SOC	-	-	-	-	-	-	0.94** (SEM = 0.18) (<i>t</i> = 5.24)	-	0.94** (SEM = 0.18) (<i>t</i> = 5.24)
SDT	-	-	-	0.28* (SEM = 0.11) (<i>t</i> = 2.50)	-	0.28* (SEM = 0.11) (<i>t</i> = 2.50)	-0.11 (SEM = 0.15) (<i>t</i> = -0.76)	0.27 (SEM = 0.17) (<i>t</i> = 1.84)	0.16** (SEM = 0.05) (<i>t</i> = 2.97)
SE	-	-	-	0.39** (SEM = 0.09) (<i>t</i> = 4.30)	-	0.39** (SEM = 0.09) (<i>t</i> = 4.30)	-	0.36** (SEM = 0.06) (<i>t</i> = 6.17)	0.36** (SEM = 0.06) (<i>t</i> = 6.17)
POC	-	-	-	0.33** (SEM = 0.09) (<i>t</i> = 3.69)	-	0.33** (SEM = 0.09) (<i>t</i> = 3.69)	-	0.31** (SEM = 0.07) (<i>t</i> = 4.51)	0.31** (SEM = 0.07) (<i>t</i> = 4.51)
DB	0.86** (SEM = 0.05) (<i>t</i> = 16.55)	-	0.86** (SEM = 0.05) (<i>t</i> = 16.55)	-	0.29** (SEM = 0.08) (<i>t</i> = 3.60)	0.29** (SEM = 0.08) (<i>t</i> = 3.60)	-	0.27** (SEM = 0.06) (<i>t</i> = 4.40)	0.27** (SEM = 0.06) (<i>t</i> = 4.40)
SMCSE	0.74			0.78			0.73		

Note: DE = direct effect; IE = indirect effect; TE = total effect; SE: self-efficacy; DB: decision balance; POC = process of change; SOC = state of change; SDT = self-determination theory; SEM = standard error of mean; SMCSE: squared multiple correlations for structural equation. **p* < .05, ***p* < .01.

Dotted arrows represent indirect effect while continuous arrow represents direct effect. The numbers represent the strength of correlation between model components. Values above 0.5 indicate stronger correlation and below this value, correlation is considered as weak. Also, SDT had no direct relationship with MEB and SOC. SE = self-efficacy; SE1 = negative effect; SE2 = excuse making; SE3 = must exercise alone; SE4 = inconvenient to exercise; SE5 = resistance from others; SE6 = bad weather; POC = process of change; POC1 = cognitive or experiential processes; POC2 = behavioral

processes; DB = decisional balance; DB1 = positive aspects of exercise behavior; DB2 = negative aspects of exercise behavior; SDT = self-determination theory; SDT1 = extrinsic motivation; SDT2 = introjected regulation; SDT3 = identified regulation; SDT4 = Integrated regulation; SDT5 = intrinsic motivation to learn; SDT6 = intrinsic motivation to accomplish the tasks; SDT7 = intrinsic motivation to experience sensation; MEB = maintenance exercise behavior; MEB1 = frequency; MEB2 = intensity; MEB3 = time/duration; MEB4 = type; MEB5 = attitude.

Discussion

Three broad components formed the theoretical framework of this population survey; the first, TTM, was applied to deduce the association between SOC, POC, SE, DB and MEB. The second, SDT, was applied to understand the role of motivation in MEB; the third, MEB, was applied to understand the factors influencing participants approach toward physical exercise. The relationships between these components were evaluated using likelihood-based estimations. The Pearson correlation coefficient also indicated that all theoretical constructs used as latent variables were highly correlated with MEB. However, in the structural equation model, SE, POC, DB and SDT were correlated with SOC. The strength of correlation with SOC also determined the model fit to collected data. Though SOC had moderate positive correlation with MEB, unlike other terms of TTM construct, it also had a direct effect with MEB; hence, it was used as a mediator variable to assess the current exercise behavior of participating staff. Studies have shown that factors which directly influence progression at any SOC were likely to affect MEB (Han et al., 2017). This justifies the choice of latent variables used in the current study. In a similar study conducted previously, TTM and SDT were shown to be good predictors of exercise behavior. It was also reported that SDT not only acts as a motivational tool but was used for assessment of basic physiological needs of individuals (Farmanbar et al., 2011). In contrast to their study which included all constructs of TTM and SDT, the questionnaire used in the present study was a curated version. In addition to reducing the variability of outcome, work-load on the participants was also minimized.

The final model presented in the figure above was selected by comparing its fit indices with a null model. Model selection was strictly based on the rule of parsimony which favors selection of model with less parameters. Considering the fit index criteria ($\chi^2 = 110$, $p = .190$, GFI = 1, RMR = 0.040, SRMR = 0.037, RMSEA = 0.016, CFI = 1, and AIC = 106.09), the structural equation model reported herein had a better fit and can be considered reliable compared to that reported previously (Farmanbar et al., 2011). The selected model also had low χ^2 , lower df and p values greater than 0.05, and lower AIC, which corresponds with the recommendation for determining model reliability and selection based on maximum likelihood (Tabachnick et al., 2007). In this model, SE (0.39) and POC (0.33) and SDT (0.28) had the highest correlation with SOC. Though DB had an indirect correlation with SOC, it had a strong effect (0.86) on POC. Overall, all components fitted to these constructs can be considered good predictors of MEB.

The construct, SE was an important predictor of exercise behavior in the selected model, an observation that agrees with report elsewhere (Shaver et al., 2019). According to their study, it was shown that individuals with higher SE tend to move more progressively towards a higher SOC. It has also been emphasized that SE had the strongest association with physical activity in virtually all known studies (Keating et al., 2005; Sallis & Owen, 1999). Another report showed that SE was a strong predictor of physical activity behavior in a sample of university students (Levy & Cardinal, 2006). After examining the relationship between POC, SE, and DB during physical exercise among college students, a significant distinction in SE scores between those who relapsed and the physically active participants revealed that it can be used as an index to predict an individual's SOC (Farmanbar et al., 2009).

In the current study, SDT had a direct effect on SOC, even though it was the weakest predictor of all. The weak association between SDT and MEB in the model reflected the motivational stage of the participants at the time of survey. Approximately 50 percent of the participants in this study were inactive and needed to overcome various barriers to MEB (Mallett et al., 2007). Deci and Ryan (1985) proposed that individual need satisfaction must often be backed by motivation (intrinsically or extrinsically) to effect the desired behavioral change. A group of German scientists evaluated workplace physical activity with or without motivation for one year. Parameters assessed during the study were the strength of goal intention, SE, outcome expectations, action planning, and barrier management. It was observed that motivation in the form of coaching had a significant impact on physical activity, (Klain et al., 2015). Another study reported that both autonomous and/or extrinsic motivation can progressively lead to MEB over time (Vlachopoulos & Karavani, 2009).

The finding that POC had the second largest effect on SOC in the present study corresponds with reports in previous studies (Hwang & Kim, 2011; Liu et al., 2018; Romain et al., 2014). Liu et al. (2018) reported that SOC was highly significant and positively associated with POC; hence, was the strongest predictor of physical activity in a sub-sample of university students. They also reported that individual perception towards a particular physical activity could influence their engagement either positively or negatively. The current observation also accords previous finding that both cognitive and behavioral POC were correlated at all stages of change. It was further shown that sensitizing individual consciousness as well as re-evaluation of limiting environmental constraints were motivating factors for engagement in physical activity (Hwang & Kim, 2011). In another study, it was reported that POC were better predictors for evaluating individual progression from one

SOC to another (Romain et al., 2014). It was also shown that cognitive and behavioral POC were good predictors of physical activity behavior (Han et al., 2017).

Decision balance had a strong correlation with POC, a finding that was observed in previous studies (Collins et al., 2009; Keller & McGowan, 2001). In both studies, it was observed that incorporating pros and cons increased the predictability of behavior change pattern. In another study DB served as an indicator when planning intervention programs for individuals at different stages of change. However, it was shown that individual response to pros and cons of behavior modification was also influenced by their respective SOC, with contemplators being more susceptible to causal predominance than individuals in action stage (Pollak et al., 1998). The result of the present study and previous findings shows that an individual's evaluation of pros and cons is critical to initiate a deliberate action plan towards a behavior change. In fact, all pros (but not cons) had significant positive influence on adaptation to physical activity (Kim, 2021). Interestingly, the current finding has so far proffered a clearer understanding of the current exercise behavior of university staff and has shown that an integrated model of TTM and SDT could be a more reliable approach for exercise behavior motivation than when used exclusively.

Conclusion and Recommendations

To the best of our knowledge, this was the first independent study integrating the constructs from TTM and SDT in the study of MEB in Thailand. This study revealed that SOC is the only construct of TTM directly correlated with MEB; hence, the impacts of all other terms of the construct (including POC, SE and DB) depend on the assessment of an individual's willingness to transcend through SOC. Lack of motivation has been identified as an impediment to MEB. Furthermore, SE and DB have the strongest correlation with SOC and so can be useful as a promotional tool. Additionally, emphasis on the advantages of physical exercise should be reiterated through advertisements and communally organized exercise events. Individuals who have transcended barriers to physical activity should receive follow up from their trainers to reduce the chance of relapse. Because exercise behavior must be internalized to become a consistent lifestyle, the appropriate use of TTM constructs as a promotional tool must be balanced by SDT to foster decision making toward a healthy lifestyle that is not devoid of physical exercise. Because lack of motivation impedes MEB, the need to integrate SDT and TTM in behavior modification studies is therefore pertinent.

Interestingly, the finding that SE has a strong positive effect on SOC and together with SDT indirectly affects MEB simply indicates that when internal belief in oneself is backed by motivation (in the form of environmental support or education), long-term behavior modification can be enhanced. Future studies will focus on the association between SE and internal motivation in promoting motivation and exercise behavior.

Study Limitations

Due to the complexity of factors that influence human behavior, association might not imply causality and causality might not be inferred.

Conflict of Interest

There are no conflicts of interest to declare with respect to the study, authorship, and publication of this article.

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