



A causal model of exercise behaviors among undergraduate students based on the PRECEDE model

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Abstract

This research aimed to develop and examine the validity of a model of causal relationships among predisposing factors (PF), enabling factors (EF), and reinforcing factors (RF) that affected the exercise behavior (EX) of students at Prince of Songkla University. The sample was 418 undergraduate students at Prince of Songkla University, Hat Yai Campus, selected using a multistage random sampling method. The instrument used was a questionnaire. Statistical data were analyzed using frequency, mean, percentage, and standard deviation, confirmatory component analysis, and linear structural equation model analysis (path analysis). The results revealed that the causal model of exercise behavior among undergraduate students according to the PRECEDE health promotion planning concept corresponded well with the empirical data (Chi-square; $\chi^2 = 60.900$, $df = 46.00$, $p = .06$, GFI = 0.98, AGFI = 0.96, CFI = 1.00, SRMR = 0.03, and RMSEA = 0.02). The variables in the model accounted for 71 percent of the variance in exercise behavior. The variable (PF) had a direct influence on (EF) and (EX), with effect sizes of 0.71 and 0.34, respectively, and had an indirect influence on (RF) through (EF) and (EX) with effect sizes of 0.60 and 0.40, respectively. In addition, (EF) had a direct influence on (RF) and (EX), with effect sizes of 0.85 and 0.44, respectively, while (EF) was indirectly influenced by (EX), with an effect size of 0.12. Additionally, (RF) directly influenced (EX), with an effect size of 0.14, which was statistically significant at the .01 level.

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Introduction

Physical inactivity is a critical concern and a top health promotion priority for the World Health Organization (WHO) internationally. The primary goal is to enhance

global health, reducing the risks and prevalence of chronic non-communicable diseases (NCDs) such as obesity, diabetes, cardiovascular diseases, and various cancers (Department of Disease Control, 2022). Insufficient physical activity, often coupled with sedentary behavior,

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contributes to the onset of NCDs, potentially leading to premature mortality (World Health Organization, 2023). Currently, one in four adults and four in five adolescents worldwide do not engage in adequate physical activity. Consequently, over 5 million deaths annually are attributed to physical inactivity. Moreover, the economic burden resulting from insufficient physical activity exceeds 68 billion US dollars each year (Guthold et al., 2018). A WHO survey reported that physical inactivity accounts for 3.2 million deaths globally each year (World Health Organization, 2023). This problem not only causes health detriments but also significantly affects economic and social development.

In Thailand, the COVID-19 outbreak in 2020 significantly impacted all aspects of human life, including the health behaviors related to physical activity of Thai people, whether in work, travel, or exercise. Consequently, the average daily sedentary time for Thai individuals increased to 14 hours and 32 minutes, exceeding the usual duration. It is noted that the average sedentary behavior duration among Thais rose to 15 hours (Wongpipit, 2022). Concurrently, chronic non-communicable diseases (NCDs) accounted for up to 71 percent of all deaths in the Thai population, with one contributing factor being inadequate physical activity among one in three Thais nationwide (Hfocus, 2019). Data from the 2019–2020 physical activity survey indicated a decline in adequate physical activity levels among Thais from 74.6 percent in 2019 to just 55.5 percent, a decrease of 19.1 percent (Katewongsa, 2021). Additionally, 30.9 percent of Thais aged 15 and over engaged in insufficient physical activity (28.9 % of men and 32.7 % of women). This represents an increase from the 2014 survey figures (18.4 % of men and 20.0 % of women) (Aekplakorn, 2021). The National Health Examination Survey (NHES) data from 2008–2009, 2014–2015, and 2019–2020 for Thais aged 15 years and older revealed an upward trend in individuals not meeting physical activity recommendations, with an increasing prevalence of abnormal body mass index ($BMI \geq 25 \text{ kg/m}^2$) and abdominal obesity (waist circumference $\geq 90 \text{ cm}$ for men and $\geq 80 \text{ cm}$ for women), reflecting an imbalance between exercise and food intake (Department of Disease Control, 2022). This trend may contribute to a rising incidence of NCDs in Thailand.

However, education alone is insufficient to effectuate the desired changes in health behavior because such behaviors are influenced by a variety of factors, both intrinsic and extrinsic to the individual (Crosby & Noar, 2011). Key determinants include cultural background, beliefs, values, social factors, and physical

factors that impact the quality of life (Lapratthanathong et al., 2022). Moreover, there are numerous theories on behavior change, each with distinct principles. This article examines the application of the PRECEDE-PROCEED model (Green & Kreuter, 2005), utilizing the PRECEDE framework as a diagnostic tool for identifying behavioral causes (Salinero-Fort et al., 2011). We employed it as a conceptual framework for analyzing situations and problems and identifying factors related to the exercise behaviors of undergraduate students at Prince of Songkla University, encompassing a comprehensive range of multifactorial influences. These include predisposing factors that motivate behavior such as knowledge and attitudes, which are associated with physical activity behavior (Keawvilai, 2009; Kengganpanich, 2003; Siangsai & SuKonthasab, 2015; Sukonthasab, 2002; Sutthajunya, 2006). Enabling factors facilitate individuals' ability to act on their desires as a result of predisposing factors; these may include physical facilities and policies that support individual behavior (Keawvilai, 2009; Leemingsawat et al., 2007; Siangsai & Sukonthasab, 2015; Sutthajunya, 2006). Additionally, reinforcing factors are benefits or reinforcements that students receive or expect from others as a result of their actions (Powwattana et al., 2012). Previous studies have indicated that reinforcing factors are positively correlated with physical activity behavior and that social support for health promotion is associated with health-promoting behaviors (Aunprommee, 2009; Siangsai & Sukonthasab, 2015; Sutthajunya, 2006).

From the discussion above, it is evident that exercise and physical activity practices are correlated with health status and are considered fundamental to life. Consequently, higher education institutions must play a pivotal role in health promotion for students by creating and enhancing the physical and social environments to facilitate healthful behaviors, encourage productive use of free time, and foster continuous and sustainable living (Office of the Higher Education Commission, 2011). This ensures that students maintain good health, are prepared for a happy societal life, and can adapt effectively to changing circumstances. For these reasons, the researchers are interested in developing a model of causal relationships among factors affecting exercise behavior among undergraduate students at Prince of Songkla University, based on the PRECEDE model of health promotion planning. The aim is to validate the model with empirical data and use the study's findings as a guideline for planning and developing health promotion initiatives to support Prince of Songkla University students in achieving optimal health, as they are vital for

the country's future development.

Theoretical Framework

Based on the literature review, we hypothesized that the PRECEDE model of health promotion planning could explain the causal relationships among factors influencing the exercise behavior of undergraduate students at Prince of Songkla University. Consequently, this model was employed to establish the conceptual framework and research hypotheses. The details are illustrated in [Figure 1](#).

Materials and Methods

This research aimed to explain the causal relationship model of factors affecting the exercise behavior of undergraduate students at Prince of Songkla University, based on the PRECEDE model for health promotion planning, supported by empirical data. Consequently, the researchers emphasized the significance of internal validity in this study, as it involved the investigation and determination of cause-and-effect relationships between the variables examined. The following steps and methods have been established for conducting the research:

Participants

The study population comprised undergraduate students enrolled at Prince of Songkla University, Hat Yai Campus, as of 23 August 2022. According to data from

the Student Registration and Statistics Office, there was a total population of 16,438 students (Registration and Processing Department, 2022). The researchers selected a sample size of 418 students, calculated using the proportional sampling formula at a 99 percent confidence level according to Jaeger, with an error margin (e) set at 0.05 (Chamonman, 1994). This consideration also aligned with the preliminary consensus on determining sample size for causal model analysis, which recommends at least 20 participants per observed variable. With a total of 13 variables in this study (Hair et al., 2010), this equates to 260 students. To ensure data completeness following structural equation modeling analysis principles, a sample size of 418 students was collected. A multistage random sampling method was employed with the following steps: 1) Categorize the population by subject field groups in descending order based on student population size. 2) Divide the population into stratified groups according to student population size using stratified random sampling. 3) Perform random sampling within each group by drawing lots to select representatives from two faculties per group, resulting in six faculties: Faculty of Engineering, Faculty of Agro-Industry, Faculty of Nursing, Faculty of Veterinary Science, Faculty of Law, and Faculty of Liberal Arts. 4) Determine the sample size for each group proportionally based on the number of students from each randomly selected faculty.

Ethics

The research was carried out upon the prior consent

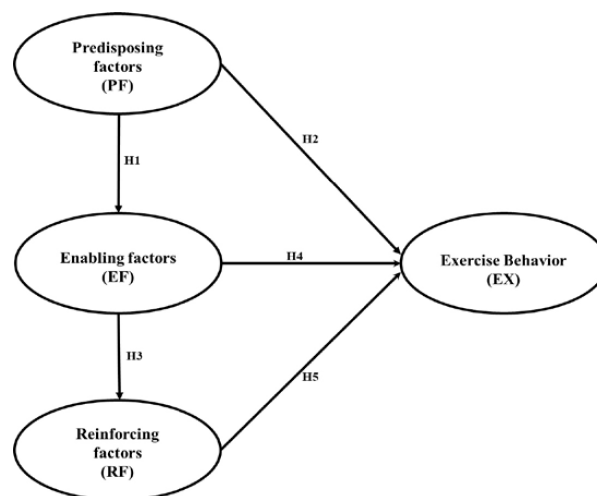


Figure 1 Conceptual framework and hypotheses for the causal relationship model of factors influencing exercise behavior among undergraduate students at Prince of Songkla University, based on the PRECEDE health promotion planning concept

of the Ethical Committee of the Center for Social and Behavioral Sciences Institutional Review Board, Prince of Songkla University (No. PSU IRB 2023-LL-Libarts-014 (Internal)). The participants were informed of the objectives of the study and that they had the right to withdraw from the research study at any time without any penalty or consequences. In addition, they were informed that the information they provided would be kept strictly confidential and reported as overall results.

Instruments and Procedure

The tool used in this research was a questionnaire developed by the researchers from a literature review and related research on the PRECEDE model of health promotion planning, and principles of exercise for health. It was divided into 5 parts as follows:

1. General Information: This section included gender, academic year, field of study, sports or exercise experience, and places for exercise—a total of 5 items presented as a checklist.

2. Exercise Behavior: Measurement adapted from Mattayakorn et al. (2016), Comprising 4 components: frequency, intensity, duration, and type of exercise, totaling 26 items. This section utilized a 5-point rating scale allowing respondents to select only one answer.

3. Predisposing Factors related to exercise behavior, comprising 4 components: knowledge, attitude, values, and beliefs—15 questions in total. The questions were formatted as a Likert 5-point rating scale allowing respondents to select only one answer.

4. Enabling Factors facilitating exercise behavior, comprising 3 components: available resources, access to resources, and skills—10 items in total. The format was a 5-point Likert scale allowing respondents to select only one answer.

5. Reinforcing Factors related to exercise behavior, comprising 2 components: individual opinions, and 7 rules/items. The question format was a 5-point Likert scale allowing respondents to select only one answer. Parts 2 to 5 had valid Index of Item Objective Congruence (IOC) values between 0.67 - 1.00 (Rovinelli & Hambleton, 1977), and reliability was tested using Cronbach's alpha coefficient for predisposing factors, enabling factors, reinforcing factors, and exercise behavior. The coefficient values for these four factors were 0.80, 0.82, 0.79, and 0.75 respectively.

The researchers prepared a memorandum requesting permission for data collection and attached an invitation for students to participate in the research project questionnaire, along with a QR Code and a link to the

online questionnaire. This was disseminated through six faculties randomly selected to represent Prince of Songkla University's Hat Yai Campus. Data collection utilized online questionnaires that did not require respondents to provide identifiable information. Since the data collection was conducted online, volunteers could not physically sign a consent form; instead, they could click a button to either consent to or opt out of participating in the online questionnaire. Only fully completed questionnaires were selected for data analysis using statistical methods.

Statistical Analysis

The basic information of the respondents was analyzed using descriptive statistics, which included frequency, mean, percentage, and standard deviation. The relationships between the observed variables were examined by calculating Pearson's product-moment correlation coefficient to determine the interrelations among the model's variables. The consistency of the measurement model for each of the four components was tested using confirmatory factor analysis. The causal relationships between predisposing factors, enabling factors, reinforcing factors, and exercise behavior were analyzed using a linear structural equation model with path analysis. Additionally, the validity of the hypothesized model was evaluated against empirical data by considering goodness-of-fit measures and analyzing residuals or discrepancies (Fitted Residuals Matrix) (Schumacker & Lomax, 2010).

Results

The basic data analysis of the respondents revealed that the majority of the sample was female, with 215 individuals (51.40 %), followed by males at 193 individuals (46.20 %), 8 LGBTQ individuals (1.90 %), and 2 persons of unspecified gender (0.50 %). The breakdown by academic year was as follows: 241 first-year students (57.70 %), 48 second-year students (11.50 %), 81 third-year students (19.40 %), 47 fourth-year students (11.20 %), and 1 individual above fourth-year (0.20 %). The majority of the sample studied in the field of science and technology, totaling 1,612 individuals (38.50 %), followed by health sciences at 151 individuals (36.10 %), and humanities and social sciences at 106 individuals (25.40 %). Additionally, a significant portion of the sample, 361 participants (86.40 %), had experience in exercising, while 57 participants (13.60 %) did not. Most of the sample group, 285 participants (68.20

%), exercised within Prince of Songkla University, whereas 133 participants (31.81 %) exercised outside the university.

The analysis revealed that the correlation coefficient analysis of the observed variables indicated causal relationships among factors influencing undergraduate students' exercise behavior at Prince of Songkla University, in line with the health promotion planning principles of the PRECEDE model. The analysis is suitable for further model evaluation since each variable significantly correlates with others at the .01 level, with coefficients ranging from 0.147 to 0.674. To avoid multicollinearity or an overspecified model, it is essential that no pair of variables has a correlation coefficient exceeding .90 (Wiratchai, 1999).

The consistency testing of the measurement model, which examines causal relationships among factors affecting the exercise behavior of undergraduate students at Prince of Songkla University based on the PRECEDE model for health promotion planning, indicated that all four variables had appropriate mean levels, averaging 0.863, with standard deviations ranging from 0.54 to 0.68. The coefficient of variation (CV) for each latent variable showed minimal distribution differences, ranging from 12.45 to 16.14 percent. Regarding the observed variables' distribution, the skewness (Sk) values ranged from

-0.127 to 1.254, and the kurtosis (Ku) values ranged from 0.112 to 1.213, aligning with the normality criteria that skewness should not exceed 3.00 and kurtosis should not exceed 10.00 (Rex, 2011). This suggests that the variable data were neither skewed nor excessively peaked, making them suitable for further analysis.

The analysis of the causal relationships among predisposing factors, enabling factors, and reinforcing factors affecting the exercise behavior of Prince of Songkla University students revealed that the adjusted model was consistent with the empirical data. The fit indices were as follows: ($\chi^2 = 60.900$), $df = 46$, $p = .069$, $\chi^2/df = 1.324$, RMSEA = 0.028, GFI = 0.980, AGFI = 0.960, CFI = 1.000, SRMR = 0.030). See Figure 2.

When considering the path coefficients, direct influence, indirect influence, and total influence from external latent variables affecting internal latent variables, as well as the influence from internal latent variables affecting each other, it was found that all variables in the model could explain 71 percent of the variance in exercise behavior among students at Prince of Songkla University. The direct and indirect influences affecting the variable (EF) were found to be directly influenced by the variable (PF) with an effect size of 0.71, and the variable (EX) was directly influenced by (PF), (EF), and (RF) with effect sizes of 0.34, 0.44, and 0.14 respectively.

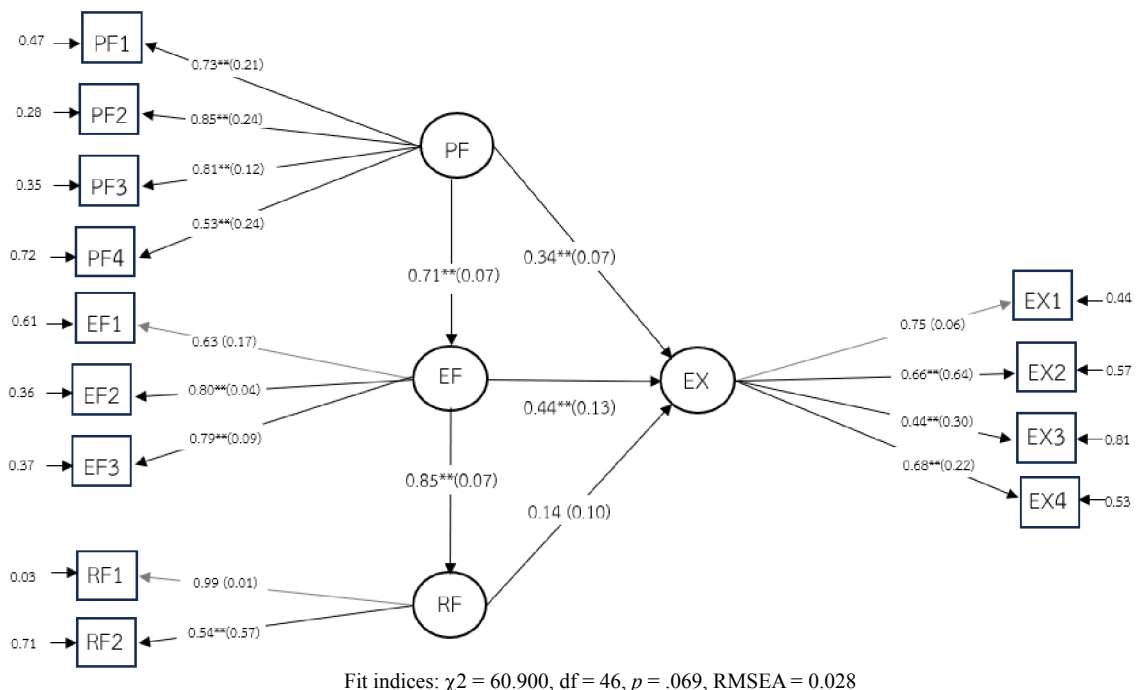


Figure 2 Comprehensive causal model of exercise behavior among undergraduate students, based on the adjusted PRECEDE model for health promotion planning

Additionally, the variable (EX) was indirectly influenced by (PF) through (EF) and (RF) with an effect size of 0.40, and (EX) was indirectly influenced by (EF) through (RF) with an effect size of 0.12. Furthermore, the variable (RF) was directly influenced by (EF) with an effect size of 0.85, and (RF) was indirectly influenced by (PF) through (EF) with an effect size of 0.60, which is a statistically significant influence at the .01 level as shown in Table 1.

The analysis of the direct and indirect influence of latent variables affecting the exercise behavior of students at Prince of Songkla University revealed that predisposing factors directly affect enabling factors and exercise behavior. Moreover, predisposing factors indirectly affect exercise behavior through enabling factors and reinforcing factors. It can be said that predisposing factors form the basis for motivating students to show

Table 1 Path coefficients of direct effects (DE), indirect effects (IE), and total effects (TE)

Causal Variables	Effect Variables								
	EF			RF			EX		
	DE	IE	TE	DE	IE	TE	DE	IE	TE
PF	0.71** (SE=0.07) (t=10.93)	-	0.71** (SE=0.07) (t=10.93)	-	0.60** (SE=0.04) (t=13.50)	0.60** (SE=0.04) (t=13.50)	0.34** (SE=0.07) (t=5.04)	0.40** (SE=0.06) (t=7.11)	0.74** (SE=0.06) (t=12.38)
EF	-	-	-	0.85** (SE=0.07) (t=12.30)	-	0.85** (SE=0.07) (t=12.30)	0.34** (SE=0.07) (t=5.04)	0.40** (SE=0.06) (t=7.11)	0.74** (SE=0.06) (t=12.38)
RF	-	-	-	-	-	-	0.14 (SE=0.10) (t=1.45)	-	0.14 (SE=0.10) (t=1.45)
R-Square	.51			.72			.71		

** $p < .01$ (Chi-square = 60.900, $df = 46$, $p = 0.069$, RMSEA = 0.028, GFI = 0.980, AGFI = 0.960)

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

Note: Predisposing factors (PF), Enabling factors (EF), Reinforcing factors (RF), and Exercise Behavior (EX)

Discussion

The causal relationship model of factors affecting the exercise behavior of undergraduate students at Prince of Songkla University, which was developed based on the PRECEDE health promotion planning model (Green & Kreuter, 2005), is consistent with empirical data and falls within the good range. This is considered by the Chi-square value, which is not significantly different from zero statistically, indicating that the main hypothesis that the model is consistent with empirical data is accepted. The indices measuring the level of consistency, such as Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI), are close to 1. Root Mean Square Residual (RMR) and Root Mean Square Error of Approximation (RMSEA) are close to 0, and Critical N (CN) is greater than 200, all of which meet the specified criteria for model fit verification (Schumacker & Lomax, 2010). The latent variables within the model can explain 71 percent of the variance in exercise behavior among students at Prince of Songkla University, which meets the criterion of explaining at least a minimum of 50 percent variance of the specified variables (Hair et al., 2010). The explanation can be described as follows.

their exercise behavior, such as perceiving the benefits of exercising, perceiving barriers to exercise, and knowledge about exercise that students can practice, obtained from accumulating learning experiences from the past to the present. Additionally, some students have registered for physical education courses in the general education group of courses, which helps support health-related behaviors. The results of this study are consistent with the study by Boonsem et al. (2021), which examined the causal relationships of various factors and exercise behavior affecting the physical fitness of university students based on the PRECEDE model framework. It was found that predisposing factors, enabling factors, and reinforcing factors have a positive effect on exercise behavior. The results of the study can be used as guidelines to continuously promote exercise behavior among university students, leading to improvements in physical fitness in all aspects. This is in line with Kakai and Suksombat (2021), who found that knowledge factors leading to exercise have been accumulated from education starting from primary, secondary, and university levels, and knowledge about exercise through various media has a direct effect on factors that facilitate exercise behavior. Additionally, Palitnonkert et al. (2018) found that students have a high level of exercise behavior because

they learn about body movement in practice during class hours, giving them both theoretical and practical knowledge. Kumyoung et al. (2021) discovered that students at Loei Rajabhat University engage in exercise and daily activities with a focus on health, leading to consistent exercise to maintain body balance. Moreover, exercising also provides opportunities to meet friends and build relationships, making it enjoyable to exchange ideas with others. Furthermore, predisposing factors related to knowledge and understanding of exercise are associated with enabling factors for exercising. Additionally, predisposing factors indirectly affect exercise behavior because students receive information from various online sources. In today's era of rapid technological development, health-related information is easily accessible, which results in stimulation to make decisions that lead to exercise behavior (Khirathan et al., 2022). This corresponds with the study by Sripoka et al. (2020), which found that students have a moderate overall level of knowledge about exercise for health, with a frequency of exercising 1–2 times per week and a more positive attitude than those who exercise more than 5 times per week. This may be due to specific cognitive factors related to behavioral expression, which is an important issue for students to adapt and change their exercise behavior appropriately. Tanchaisak and Wattanapanit (2020) studied the attitudes of working-age citizens, aged 21 and over, toward exercise and the type of services that working-age citizens expect or want to receive from fitness centers in Bangkok. It was found that the sample group had a positive attitude towards exercising and had similar expectations regarding the services of fitness facilities. Most of the demands focused on location and equipment that must be convenient for members, and staff should be polite, providing good advice and service, which will help stimulate the sample group to increase their exercise behavior.

Enabling factors directly influence reinforcing factors and exercise behavior. Moreover, enabling factors also indirectly affect exercise behavior through reinforcing factors. It can be said that arranging the environment of dormitory areas, and public spaces within Prince of Songkla University to be easily accessible for students, by organizing health gardens, and exercise activity areas, and ensuring that exercise equipment is in good condition and ready to use, as well as having service points for borrowing and returning sports equipment both during and outside office hours, supports and encourages students to increase their exercise behavior. This is in line with Kakai and Suksombat (2021), who found that environmental support factors, including locations,

various sports equipment, and facilities for exercising in many places, along with a security system and easy access to services both outside and inside the university, will motivate students to exhibit more behaviors that promote their health. In the study by Boonsem et al. (2021) on the relationship between various factors and exercise behavior affecting the physical fitness of university students within the PRECEDE model framework, it was found that enabling factors support the occurrence of exercise behavior. Environmental conditions and support from family members and friends have a direct effect on exercise behavior. This corresponds with the research findings of Yao et al. (2024), which indicated that environmental enabling factors are crucial in exercising because they motivate students to engage in physical activities. The availability of a variety of facilities and adequate equipment in good working conditions plays a positive role in encouraging students to increase their exercise and sports behavior. Furthermore, Lin et al. (2012) studied the work environment and psychosocial factors affecting the physical activity of working-age people in Taiwan. They discovered that specific confidence in performing sports skills is positively related to physical activity and is the most influential factor in exercising. Additionally, arranging the work environment has a positive correlation with exercising, and physical movement or exercise during the day helps significantly reduce work-related stress statistically.

Reinforcing factors have a direct effect on exercise behavior. This study suggests that students receiving information, news, and knowledge about sports and health-promoting physical activities from announcements, media, or various publications are stimulated to increase their exercise behavior. Support from friends, family, and relatives, as well as the organization of health-promoting sports activities at the university, also contribute to this effect. This research result is consistent with Zhang et al. (2024), who found that following news helps motivate exercise and leads to health beliefs, including setting goals to take care of one's own health. Information and knowledge about sports or physical activities are linked to interest in supporting exercise and also serve as a stimulus for the desire to participate directly. Similarly, the study by Li et al. (2024), found that social reinforcing factors affect students' self-worth and directly determine habits related to exercise behavior. Furthermore, reinforcing factors in educational institutions, fitness facilities, and environmental conditions such as family and friends have a direct effect on exercise behavior and lead to higher levels of student exercise behavior (Kholifah et al., 2017; Thøgersen-Ntoumani & Ntoumanis, 2006; Yao et al.,

2024). Additionally, health fitness facilities should adjust and expand their opening hours to suit students' needs and clearly announce rules, regulations, etiquette, and instructions for using equipment along with the benefits of each type of exercise for the convenience of student use.

Conclusion

The findings from this research can be summarized as follows: The causal relationship model of factors affecting the exercise behavior of undergraduate students at Prince of Songkla University, developed according to the PRECEDE model health promotion planning concept, was structurally valid. Enabling factors had a direct positive influence on students' exercise behavior. Therefore, Prince of Songkla University and related units can use the research results as guidelines for formulating policies to promote student health by focusing on arranging the environment of dormitories and public areas within the university to be easily accessible for students. This includes setting up health gardens, exercise activity areas, and well-maintained exercise equipment, and providing sports equipment borrowing-return points during and outside office hours. Additionally, the research found that predisposing factors directly affected enabling factors and exercise behavior, and also indirectly influenced exercise behavior through enabling and reinforcing factors. The study suggests that university health promotion units should create informational media on health, sports, and exercise activities for health, disseminating it through the university's electronic media to build correct health awareness and understanding, enabling students to choose sports and exercise activities suited to their preferences, thereby encouraging continuous exercise behavior among students.

Conflict of Interest

The author declares that there is no conflict of interest.

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