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Article

Preventing COVID-19 Spread at Home of Thai University Students through appropriate Psycho-Behavioral Model

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Abstract

The core focus in this study were predictors from three models, namely, Knowledge-Attitude-Practice model (KAP), Theory of Planned Behavior model (TPB), and Psycho-Moral Strength model (PMS) on health preventive behavior concerning COVID-19 in family context of undergraduate students, which also formed the research objectives of the study. The purpose of this experimental, quantitative study was to investigate important antecedent variables from these three psychological models. The sample of the study comprised 672 undergraduate students. The research design was non-experimental where multiple regression methods were used to derive statistical results. The findings showed that PMS model accounted for more variance of health preventive behavior than TPB model or KAP model. In addition, hierarchical MRA showed that PMS model with four components could explain the behavior significantly beyond KAP with TPB models together with 6 components. Furthermore, stepwise regression findings revealed that variables from these three models were found as important predictors which were needed for achievement concerning COVID-19 prevention, locus of control concerning COVID-19 prevention, cognitive attitude component, perceived behavioral control concerning COVID-19 prevention, and behavioral intention concerning COVID-19 prevention with 36.50% in total sample. At-risk group of this behavior were male students with high GPA. This study recommends integrating predictors from the three models for future research and interventions. Model integration should also be encouraged to heighten the precision of predictions of important behaviors required for disease prevention and pro-social behaviors.

Keywords

At-risk group, Health Preventive Behavior, Family, COVID-19, Thai undergraduate students

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The continuing widespread of the Coronavirus disease (COVID-19), all around the world since the first quarter of the year 2020, is a current global health emergency which has heavily affected worldwide economy and society, including that of Thailand. During the first wave of COVID-19 pandemic during February to September 2020, everyone in Thailand seemed cautious and scared because it was a new emerging disease with little knowledge about its cure and prevention. However, the infection rate by the third quarter of the year 2020 had slowed down. The government allowed to re-open some organizations, businesses, and activities, including universities, but still enforced the new normal measures of D-M-H-T-T that were 1) distancing 2) mask wearing 3) hand washing, 4) temperature testing, and 5) check in application Thaichana.

During the last four months of the year 2020, undergraduate students were designated to study online at home, thus spending more time at home. They had to contact and communicate with their family members more often. Many undergraduate students may have to take more responsibilities in helping their parents and older family members for their daily life, such as, grocery shopping, going to the hospital to get medicine, sending mail and parcels. Taking up the duties like these also increased the chance of COVID-19 infection and transmission.

Despite the hard efforts on reminding of new normal measures, the COVID-19 infection, resulting from contacting closed persons in the family was repeatedly reported (Department of Disease Control, 2020). Thus, a question urgently needed to be answered about the important predictors for enhancing health preventive behavior concerning COVID-19 in the family context of the undergraduate students.

In psycho-behavioral science of health studies, most research interests and approaches have been limited to knowledge, belief, and attitudes in relation to health prevention and promotion (KAP). Especially for COVID-19 prevention, most recent studies have repeatedly employed similar approaches mentioned above (Kim et al., 2022; Sombultawee et al., 2021). Another famous model which emphasizes social and situational antecedents of behavior, is theory of planned behavior (TPB) (Ajzen, 1991). This model is now a leading approach in studying health prevention and promotion, especially concerning COVID-19 (Adiyoso, 2021; Frounfelker et al., 2021). Beside these models, social psychologists suggested that there are many other important psychological characteristics that can drive a behavior, especially health behavior, mentioned both in former studies (Dassen et al., 2015; Wallston et al., 1976), as well as in recent studies (Devereux et al., 2021; Pedron et al., 2021). Unfortunately, most of these studies employed only one major psychological characteristic in association with health behavior. Consequently, the magnitude of explaining behavior is rather low and unsatisfactory (Mischel, 1973).

To fill this gap, multiple components of psychological and moral characteristics, such as personality, motivation, reasoning, should be used together with the two traditional models mentioned above. Thus, this study aimed at investigating possible predictors from three models, namely, 1) Knowledge-Attitude-Practice model (KAP), 2) Theory of Planned Behavior model (TPB), and 3) Psycho-Moral Strength model (PMS) on health preventive behavior concerning COVID-19 in family context of undergraduate students.

There are three research objectives in this study. First, to compare the magnitudes of associations between the psychological states and the preventive behavior from PMS Model with those from TPB and KAP models. Second, to examine whether the PMS model can account for the variance of the target behavior beyond the KAP and the TPB models. Third, to identify at-risk types of undergraduate students who show less amounts of preventive behaviors, and to pinpoint the protective factors for future enhancement.

Literature Review

- *Health prevention behavior in the family*

In the present study, health preventive behavior in family (HBF) was defined as the amount of reporting of appropriate behaviors at home aiming to avoid or reduce the spreading of COVID-19 from outside into the living place, as well as, minimizing the interpersonal exchange of the disease among family members by

residential arrangements and contact. During the time of a pandemic, many public health authorities recommended personal and social hygienic principles. For example, World Health Organization (2020) promoted the personal hygiene by issuing a guideline for preventing COVID-19 infection, e.g., frequently washing hands with soap or an alcohol-based hand gel, social distancing, wearing mask, etc.

The Department of Disease Control, Ministry of Public Health of Thailand (2020) and Thai Health Promotion Foundation (2020) also suggested the practice guidelines to protect and control the COVID-19 that could apply in family, e.g., wearing mask at home when interacting with family members, avoid hugging, and keeping distance, especially to aging family members, hand washing more often, using separate personal items (e.g., utensils, glass, towel), or taking shower immediately after arriving at home, etc.

Familial or residential emphasis of COVID-19 prevention behavior received less research attention than at the workplace. More systematic measure was offered in three levels; work-unit level, environmental level, and personal level (Cirrincione et al., 2020). The organization level, the suggested behavior aimed at minimizing the individuals from being exposed to the disease, where it has already been identified. But at the environmental level, the suggested measures aimed at interpersonal contact and exchange of contaminations among people, objects, areas, etc. Only at the personal level, hand washing, mask wearing, distance keeping were recommended. COVID-19 preventive behavior inventory was used on medical students in Iran. There were 9 items which emphasized avoiding the use of public places, hand hygiene and cough practice (Taghrir et al., 2020).

Health behavior has been among the major topics of research studies for many decades. Starting with health knowledge and followed by health attitudes, the body of knowledge of the antecedents of preventive disease spreading behavior and promotive healthy behaviors has been vigorously expanding. Countless number of antecedent models are offered and tested. In this study, two well-accepted models in the behavioral area of health science are urged to welcome a third model. Using research evidence-based intervention, the power of prediction of health behavior, especially, the COVID-19 prevention can be increased. In addition, with the multivariate statistical analysis, important predictors of health behavior can be pinpointed more clearly for further human development.

- *KAP model and health preventive behavior*

Knowledge, Attitudes, and Practice model (KAP) has been one of the main approaches since 1950, especially for family planning (Schwartz, 1976). Previous studies revealed that KAP model could explain various health preventive behaviors, especially relating to COVID-19 prevention (Li et al., 2021) in all three approaches, health, attitude and practices. In this study, health knowledge is defined as health literacy on COVID-19 prevention which is based on Nutbeam (2000)'s concept. Health literacy in Nutbeam's concept consists of three dimensions, i.e., functional, communicative, and critical health literacy (Nutbeam, 2000). In Norway, a health literacy study done on 2,205 adolescences with ages ranged from 16 to 19 years, showed that people were positively engaged in various practices of hand washing during the COVID-19 pandemic (Riiser et al., 2020). In another study based on 1,875 Chinese students with the average age of 19.6 years, it was discovered that health literacy was high among students who practiced greater amount of COVID-19 precautionary behaviors (Li et al., 2021). Likewise, a study in Vietnam on 5,423 students from eight universities was conducted through online assessments. Health literacy of these medical students helped them to remain away from COVID-19, and maintain good habits too (Nguyen et al., 2020).

Attitudes in previous studies has not played any important role in joining forces with knowledge to explain preventive health behavior. This may be due to many factors, such as the inconsistent operational definitions of attitudes as anxiety, fear, importance, or interest. Attitude has been divided into two components as cognitive and affective components (Eagly & Chaiken, 2007). Attitude is found in psychology research and theories as one of the more important predictors of a wide variety of actions or behaviors of human. Attitudes

and behavior to be closely related if both constructs are measured more consistently and specifically (Fishbein & Ajzen, 1975). This model has led to understand that attitude can affect health as well as psychological characteristics and behaviors (Andrade et al., 2020). In the present study, attitudes are operationally defined as having three dimensions, i.e., cognitive-evaluative dimension, affective or feeling concerning the act of COVID-19 prevention, and intention to carry out preventive behavior. These three dimensions of attitudes have been introduced and used widely in psychology and other sciences (Duchduen Bhanthumnavin & Bhanthumnavin, 2014; Krech et al., 1962). The first two dimension on cognitive-evaluative component of attitudes, and affective component of attitudes were used to form two of the three independent variables in the KAP model. The behavioral intention component of attitudes was used as one of the three independent variables in the TPB model.

The Practice approach of KAP model is based on the theory of planned behavior (TPB), which was an attempted to predict behavior by adding two aspects of perceived situations of practice, i.e., perceived social norm, and perceived behavioral control. The two characteristics of situations are seen as the push and pull or motivation factors (Ajzen, 1991).

- *TPB model and health preventive behavior*

When social norm, perceived behavioral control, and behavioral intention related to COVID-19 prevention are investigated, it is found that shared standards of accepted behavior in terms of both formal and informal standards affect an individual behavior, including health preventive behavior (Latkin et al., 2021). Another factor of perception of one's own ability to perform or control a behavior also can predict behavior. It is found that a person with high perceived behavioral control is the one who has a desirable health behavior (Godbersen et al., 2020; Pourmand et al., 2020). Several recent studies have also revealed that the stronger the behavioral intention to perform a health behavior, the more likely a person will perform that behavior (Wollast et al., 2021).

With the four major predictors of behavior (attitudes, social norm, perceived behavioral control and intention to practice), meta-analysis using 38 samples was carried out in a recent study (Starfelt Sutton & White, 2016), but only 25% of variance of sun-protective behavior was accounted for. However, stronger association was evident when measuring the behavior and four predictors at similar level, and especially in non-student respondents.

When the COVID-19 outbreak extended to an unwelcomed length of stay, many correlational studies reported using TPB model to predict preventive behaviors. Unfortunately, social distancing practices and hand washing were measured by only one to four self-report questions. Behavior intention was found to be the best predictor of social distancing and hand washing (correlation coefficients from 0.55 in Canadian adults, to 0.20 in French people). Social norm showed direct relations to social distancing practices, while having an indirect relation to hand washing via perceived behavior control (Wollast et al., 2021). At the same time, PBC had medium strength of associations with social distancing behavior in Indian and Canadians adults who were highly educated and with good health (Frounfelker et al., 2021).

Evidently, TPB Model predicted important practices to prevent COVID-19 in both easterners and westerners. However, the average percentage accounted for the behavior was only 32% in a meta-analysis report using 62 studies (McEachan et al., 2016). This signifies that the TPB model needed to increase its predictive power by expanding to cover other psychological predictors. Thus, the PMS model in the present study became an additional predictor to KAP and TPB models. In Thailand, scholars in psycho-behavior science have long been employing multiple psychological characteristics as predictors of positive behaviors including health prevention and promotion (D. L. Bhanthumnavin, 2016).

- *PMS model and health preventive behavior*

Psycho-moral strength (PMS) model is a subset of the theory of work and moral behavior (D Bhanthumnavin, 1999). It comprises four important psychological characteristics, namely, (1) locus of control (Rotter, 1966), (2) need for achievement (McClelland, 1965), (3) future orientation and self-control (De Volder

& Lens, 1982), and (4) moral reasoning ability (Kohlberg, 1994). Duchduen Bhanthumnavin and Bhanthumnavin (2021) observed that these four psychological characteristics always shared a proximal role similar to an engine of a vehicle which enabled an individual to engage and drive a behavior.

During the past two decades, research findings in Thailand and abroad have revealed that these four psychological constructs were related to many desirable dispositions and behaviors, e.g., study behavior (Boualar, 2018), and health behavior (Kopp et al., 2020; Pedron et al., 2021), especially behaviors relating to pandemic disease (Newson et al., 2022). In relation to TPB model, the PMS model seems to have at least three components as its extension. First, locus control with emphasis on "internal locus", is the belief in one's own "effort for creating outcomes". While the PBC component of TPB model consists of belief in "one's ability and situational control". Secondly, goal setting, which is implicit in TPB model, is also reflected in future orientation and need for achievement which are the two important components in PMS model. Therefore, it can be expected that PMS model with its four components can predict health preventive behavior to a greater extent than the TPB model, and beyond TPB and KAP models. In addition, the PMS model is expected to have more components as important predictors of the HBF than those from TPB model or KAP model.

Research Hypotheses

H1: PMS model yields more predictive power on HBF than KAP model or TPB model.
H2: PMS model can significantly predict HBF beyond KAP model and TPB model for at least 5%.
H3: When considered all together, the important predictors of HBF are from PMS model more than from the other two models.

Method

- *Research design*

A non-experimental single shot data gathering research design was carried out around September through October 2020 during the relaxation period after the first lockdown from COVID-19 pandemic in Thailand.

- *Participants*

The participants from four public universities in Thailand comprised 672 students (80.20% females) in junior and senior levels with average age of 21 years (SD_{age} = 0.95), and the average GPA of 3.09 (SD_{GPA} = 0.48). They majored in nursing/public health (37.80%) and in education/social science (62.20%). About 56.55% lived at home or with others and the rest lived alone.

- *Instruments*

There were four groups of variables in this study. Most of the variables were measured in the form of summated rating scale. Each measure consisted of 10-20 items. Each item was accompanied by 6-unit rating scale ranging from "absolutely true" to "absolutely not true". All measures were tried out with another group of 150 undergraduate students. Item qualities were tested by two statistical approaches, i.e., item discrimination (t-ratio) and item-total correlation. Confirmatory factor analysis was used to test construct validity (Table 1). Reliability was computed for each measure.

The first group was a dependent variable, namely, health preventive behavior concerning COVID-19 in family using factor analysis consisting of three dimensions, namely, health behavior change (e.g., handwashing, more health caution in family); (2) protective behavior (e.g., separate zones for personal belongings, no exchange of used items); and (3) avoiding disease spreading (e.g., more careful while sneezing or coughing or having illness symptoms, keeping social distance).

The second group of variables was related to the KAP model, consisted of three variables: (1) Health literacy (HL), with 19 items with the reliability of 0.799, based on Nutbeam (2000)'s three dimensions, i.e., basic health literacy, interactive health literacy, and critical health literacy; (2) Cognitive-evaluative component of attitude (CE), with 15 items with the reliability of 0.845, referred to beliefs, of advantages and disadvantages of health preventive behavior concerning COVID-19 in private and public (e.g., no need to wear mask; (3) Affective component of attitude (AC), with 12 items with the reliability of 0.814, referred to emotional attachment with the preventive behavior concerning COVID-19 in private and public (e.g., feel uncomfortable to wear mask, feel inconvenient for getting temperature checked).

The third group of variables was from theory of planned behavior (Ajzen, 1991) which consisted of three variables: (1) Social norm from significant others (SN), i.e., family (e.g., keep reminding to seriously practice the COVID-19 preventive behavior), peers (e.g., concerning separating utensils), instructors (e.g., would agree to the refraining from going out/party during the pandemic) with 20 items with the reliability of 0.833; (2) Perceived behavioral control (PBC), with 13 items with the reliability of 0.742, was defined as the perception of easiness or difficulty to practice preventive behavior concerning COVID-19 (e.g., hard to get the closed ones to cover mouth or nose when sneezing/coughing, unable to refuse to eat out with sick friends); (3) Behavioral intention (BI), with 10 items with the reliability of 0.765, was defined as readiness or willingness to practice COVID-19 preventive behavior (e.g., ready to keep distance or hand washing when coming home, intend to take shower immediately after arriving at home).

The fourth group of variables was related to psycho-moral strength model (Duchduen Bhanthumnavin & Bhanthumnavin, 2021) which consisted of four psychological states: (1) Internal locus of control (ICC) concerning COVID-19 prevention based on Rotter (1966), with 15 items with the reliability of 0.765, was defined as belief that one can predict and have control by putting more effort to get the result on COVID-19 related prevention (e.g., trying to learn more about COVID-19, keep on having good health); (2) Future orientation and self-control (FSC) concerning COVID-19 prevention (De Volder & Lens, 1982) referring to the ability to foresight future consequences from one's own actions, and create strategies for engaging and controlling one's practices, especially for COVID-19 related prevention (e.g., planning for daily activities to lower chance in getting infected), with 14 items with the reliability of 0.847; (3)Need for achievement (nAchC) concerning COVID-19 prevention, based on McClelland (1965), was defined as a desire or drive for accomplishment or mastery of task, skill or difficulty with standard or higher, especially for COVID-19 related prevention (e.g., preparation for self-quarantined) with 16 items with the reliability of 0.866; and (4) Moral disengagement (MDC) concerning COVID-19 prevention, with 15 items with the reliability of 0.808, based on Bandura (1999) and defined as cognitive processes that one uses to convince that unethical actions or behaviors are justified (e.g., hand washing is a personal rights, no behavioral change during pandemic is not too risky).

Table 1. *Summary of item and measurement qualities*

Measurements	Item used	Range of t-ratio	Range of item-total r	α	$\chi 2$	df	p-value	RMSEA (≤0.06)	CFI (≥0.95)	TLI (≥0.95)	SRMR (≤0.08)
1 HBF	13	3.75-10.47	0.31-0.56	0.757	72.076	59	0.118	0.038	0.967	0.957	0.059
2 HL	19	2.96-8.20	0.23-0.63	0.799	137.572	136	0.4462	0.009	0.997	0.996	0.06
3 CE	15	4.05-8.88	0.34-0.61	0.845	94.435	77	0.0863	0.039	0.971	0.961	0.053
4 AC	12	3.47-10.35	0.39-0.64	0.814	61.107	47	0.0811	0.045	0.966	0.952	0.051
5 SN	20	3.78-8.21	0.21-0.54	0.833	174.902	149	0.0722	0.034	0.964	0.954	0.057
6 PBC	13	3.26-7.49	0.23-0.51	0.742	72.033	57	0.0867	0.042	0.949	0.930	0.059
7 BI	10	3.89-10.28	0.30-0.58	0.765	41.81	30	0.0743	0.051	0.956	0.934	0.051
8 FSC	14	4.39-11.08	0.33-0.64	0.847	77.933	60	0.0597	0.045	0.974	0.961	0.052
9 ICC	15	3.12-8.20	0.21-0.52	0.765	103.511	84	0.0731	0.039	0.956	0.945	0.057
10 nAchC	16	4.51-12.66	0.30-0.74	0.866	103.064	84	0.0774	0.039	0.976	0.966	0.062
11 MDC	15	3.10-8.38	0.22-0.54	0.808	101.636	82	0.0699	0.040	0.959	0.948	0.054

- *Procedure*

This research proposal was approved by the Institutional Review Board (IRB) of National Institute of Development Administration. After receiving permission from the four universities, time and place were arranged for data gathering. Before administering, objectives of study and all rights of participant were informed. The informed consent was obtained from the students who were willing to participate. They filled out the paper-based questionnaires which took about 45 minutes. A small token of appreciation for each student was delivered at the end of the experiment.

- *Data Analysis*

In this study, multiple regression analysis was performed to test the hypotheses. Hypotheses 1 and 3 were tested by Enter and Stepwise Regression Analysis and to analyze data to find the predictive percentage of each model and to pinpoint significant predictors on HBF when using the 10 predictors together. Hierarchical Regression Analysis was employed to test hypothesis 2 to examine the incremental predictive percentage in the total sample. Three-way ANOVA was performed for additional analysis to find the at-risk undergraduate students who displayed less health preventive behavior. Post hoc test in terms of Scheffe′ was performed if interaction effects were found.

Conceptual Framework

The research conceptual framework of the current study is shown in Figure 1.

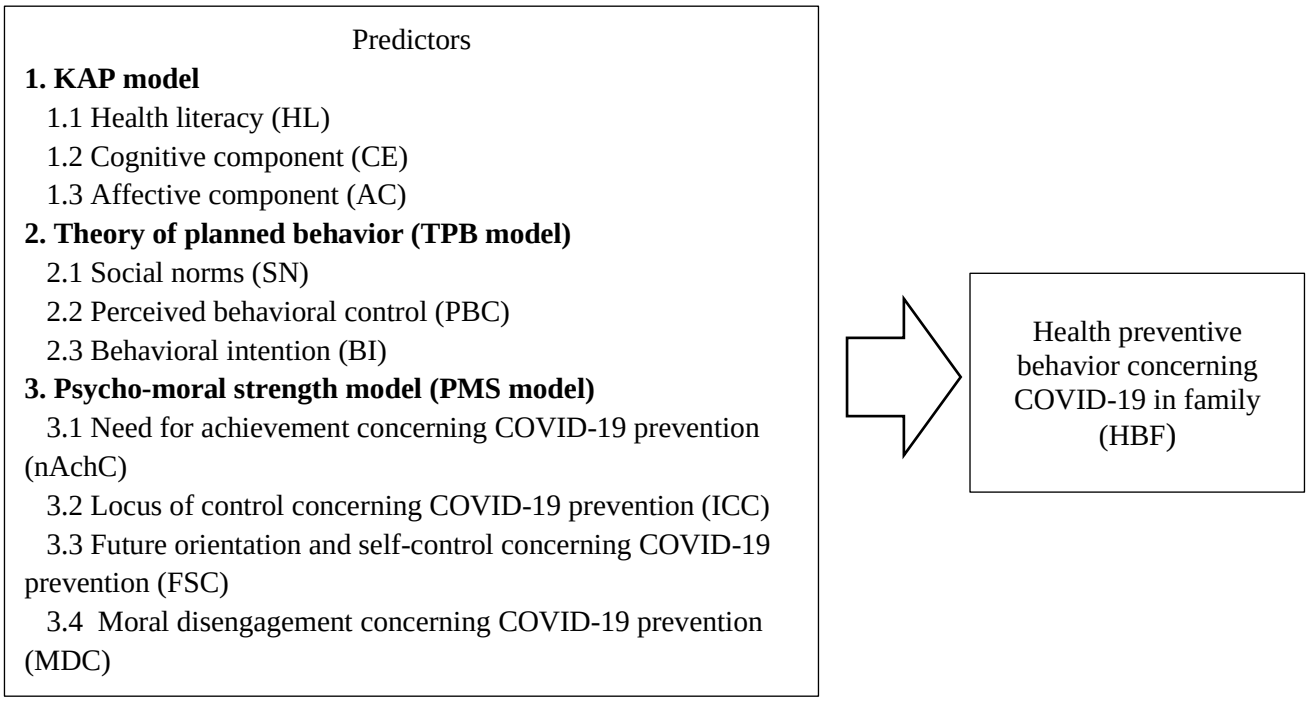

Figure 1. *Conceptual framework*

Results

Inter-correlation matrix (Table 2) shows that the highest correlation of .713 ($p<.01$) is found between two pairs of variables, namely, 1) HLC and CE, and 2) CE and AC. The rest of the correlational coefficients range from -.566 ($p<.01$) to .709 ($p<.01$).

Table 2. *Intercorrelation matrix and descriptive statistics*

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. HBF	54.36	8.33	(0.757)										
2. HL	83.42	11.23	.393**	(0.799)									
3. CE	71.45	9.57	.354**	.713**	(0.845)								
4. AC	56.91	7.89	.422**	.658**	.713**	(0.814)							
5. SN	92.48	11.93	.384**	.640**	.677**	.709**	(0.833)						
6. PBC	54.13	7.02	.441**	.581**	.586**	.608**	.649**	(0.742)					
7. BI	42.40	6.26	.468**	.534**	.532**	.555**	.567**	.656**	(0.765)				
8. ICC	67.96	8.34	.399**	.692**	.675**	.630**	.606**	.602**	.546**	(0.765)			
9. FSC	62.08	8.66	.541**	.614**	.652**	.655**	.585**	.606**	.658**	.681**	(0.847)		
10. nAchC	71.38	9.75	.536**	.592**	.581**	.606**	.571**	.552**	.587**	.620**	.693**	(0.866)	
11. MDC	41.20	11.70	-.299**	-.669**	-.566**	-.496**	-.453**	-.426**	-.374**	-.600**	-.476**	-.546**	(0.808)

Note. N= 672. *p<.05, **p<.01; Numbers in the bracket represent reliability.

Three models, namely, KAP, TPB, and PMS were compared in term of predictive power. Multiple regression approach was used to examine the predictive magnitude of the predictors from each model at a time. Table 3 indicates that KAP model can predict HBF with R^2 of 0.202. The important predictors were HL and AC. For predictors from TPB model, the three variables can predict HBF with R^2 of 0.256. All variables were the important predictors, with BI as the most important predictor. The four variables from PMS model yielded R^2 of 0.344. The important predictors were FSC and nAchC. Thus, the hypothesis 1 was supported from these results.

Table 3. *Multiple regression on HBF using predictors from each model*

Models	Predictors	B	SE	Beta	t	Sig.	R^2	Adj R^2	F	sig
KAP on HBF	(Constant)	24.350	2.398		10.153	0.000	0.202	0.198	56.211	0.000
	HL	0.148	0.038	0.200	3.861	0.000				
	CE	0.008	0.048	0.009	0.165	0.869				
	AC	0.300	0.055	0.284	5.479	0.000				
TPB on HBF	(Constant)	19.637	2.417		8.123	0.000	0.256	0.252	76.454	0.000
	SN	0.069	0.032	0.099	2.178	0.030				
	PBC	0.223	0.059	0.188	3.802	0.000				
	BI	0.384	0.061	0.288	6.324	0.000				
PMS on HBF	(Constant)	14.223	3.835		3.709	0.000	0.344	0.340	87.385	0.000
	ICC	-0.017	0.048	-0.017	-0.354	0.723				
	FSC	0.327	0.047	0.340	7.000	0.000				
	nAchC	0.281	0.040	0.329	7.017	0.000				
	MDC	0.023	0.029	0.032	0.779	0.436				

Note. HL = Health literacy, CE = Cognitive component of attitude, AC = Affective component of attitude, SN = Social norm, PBC = Perceived behavioral control, BI = behavioral intention, ICC = Locus of control concerning COVID-19 prevention, FSC = Future orientation and self-control concerning COVID-19 prevention, nAchC = Need for achievement concerning COVID-19 prevention, MDC = Moral disengagement concerning COVID-19 prevention.

Predictors from KAP model were used in the first step of analysis (see Table 4). It was found that HL and AC were the important predictors of HBF yielding the 20.20% of prediction. In step 2, three variables from TPB model were added. The result reveals the significant incremental prediction of 7.20% (F change = 22.106, p<.000). The important predictors of HBF in this step were HL, AC, PBC, and BI with the total prediction of 27.40%. In step 3, predictors from PMS model were added. The result revealed the significant incremental prediction of 9.10% (F change = 23.827, p<.000). The important predictors of HBF in this step were CE, PBC, BIFSC, and nAchC. Thus, the hypothesis 2 was supported from these results.

Regression analysis in total sample revealed that nAchC was the first important predictor of HBF, followed by ICC, CE, PBC and BI with beta coefficient of .29, .28, -.21,.11, and .10, respectively, which yielded the predictive percentage of 36.50%. In the subgroups, the predictive percentages ranged from 29.50% to 38.60% (Table 5). Similar order of important predictors was found in subgroups. Thus, the hypothesis 3 was supported from these results.

Results from three-way ANOVA using gender, GPA, and major or field of study as independent variables on HBF revealed both main and interaction effects (Table 6). For main effect, it was found that (1) female students got higher score on HBF than male students (M_{female} = 55.35, and M_{male} = 51.22); and (2) students in nursing and public health field got higher score on HBF than students in the education and social science field ($M_{nursing}$ = 54.49, and M_{edu}= 52.08).

Table 4. *Hierarchical regression analysis using three models on HBF*

		KAP							KAP+TPB							KAP+TPB+PMS						
		B	**SE**	**Beta**	**t-value**	**sig.**	**Tol.**	**VIF**	**B**	**SE**	**Beta**	**t-value**	**sig.**	**Tol.**	**VIF**	**B**	**SE**	**Beta**	**t-value**	**sig.**	**Tol.**	**VIF**
Step 1	(Constant)	24.350	2.398		10.153	0.000			17.793	2.485		7.159	0.000			12.305	4.242		2.901	0.004		
	HL	0.148	0.038	0.200	3.861	0.000	0.446	2.244	0.079	0.038	0.107	2.078	0.038	0.414	2.414	0.039	0.040	0.052	0.960	0.337	0.326	3.069
	CE	0.008	0.048	0.009	0.165	0.869	0.387	2.585	-0.053	0.048	-0.061	-1.118	0.264	0.362	2.764	-0.117	0.047	-0.134	-2.510	0.012	0.336	2.977
	AC	0.300	0.055	0.284	5.479	0.000	0.446	2.243	0.173	0.057	0.163	3.002	0.003	0.369	2.711	0.058	0.055	0.055	1.053	0.293	0.351	2.853
Step 2	SN								0.001	0.037	0.001	0.019	0.985	0.379	2.636	-0.009	0.035	-0.013	-0.249	0.803	0.375	2.667
	PBCT								0.175	0.060	0.148	2.940	0.003	0.432	2.316	0.131	0.057	0.111	2.316	0.021	0.421	2.378
	BI								0.340	0.061	0.255	5.528	0.000	0.513	1.949	0.127	0.062	0.095	2.045	0.041	0.443	2.258
Step 3	ICC															-0.046	0.051	-0.046	-0.901	0.368	0.362	2.762
	FSC															0.273	0.051	0.283	5.310	0.000	0.337	2.965
	nAchC															0.246	0.041	0.288	6.010	0.000	0.417	2.398
	MDC															0.020	0.032	0.029	0.643	0.521	0.485	2.060
R2 change				-							0.072							0.091				
F change				56.211(.000)							22.106(.000)							23.827(.000)				
R2				0.202							0.274							0.365				
F (sig)				56.211(.000)							41.822(.000)							38.070(.000)				

Note. HL = Health literacy, CE = Cognitive component of attitude, AC = Affective component of attitude, SN = Social norm, PBC = Perceived behavioral control, BI = behavioral intention, ICC = Locus of control concerning COVID-19 prevention, FSC = Future orientation and self-control concerning COVID-19 prevention, nAchC = Need for achievement concerning COVID-19 prevention, MDC = Moral disengagement concerning COVID-19 prevention.

Table 5. *Multiple regression analysis on HBF*

Groups	cases	% Prediction	Significant predictors	Beta
Total	672	36.50	9,7,2,5,6	.29,.28,-.12,.11,.10
Male	133	29.50	7	.41
Female	539	38.60	9,7,5,2	.33,.30,.15,-.11
Low GPA	341	38.00	7,9	.36,.29
Hight GPA	331	36.90	9,7,6	.30,.22,.16
Major in education and social sciences	418	34.10	9,7,6	.30,.22,.13
Major in nursing and public health	254	36.60	7,9,2,6	.36,.28,-.21,.18

Note: All beta values were statistical significance at .50.

1= HL, 2=CE, 3=AC, 4 =SN, 5=PBC, 6=BI, 7=ICC, 8=FSC, 9= nAchC, 10= MDC.

Table 6. *Three-way analysis of variance results of HBF according to gender, GPA, and field*

Dependent Variable	F-Value						
	Gender (A)	GPA (B)	Field (C)	AxB	AxC	BxC	AxBxC
HBF	13.23***	2.79	4.51*	4.69*	1.96	2.26	0.49

Note: *p<.05,***p<.001; N=672.

Furthermore, a two-way interaction on HBF between gender and GPA was found. After performing a post hoc test in terms of Scheffe' (Table 7), the results revealed four significant pairs of mean comparison. However, only two pairs were important. First, among the high GPA students, female students got higher score on HBF than male students. Secondly, among male students, the ones with low GPA got higher score on HBF than the ones with high GPA. Moreover, the results indicated that male students with high GPA got the lowest score on HBF.

Table 7. *Mean comparison on HBF according to gender and GPA*

Gender	GPA	n	code	Mean (SE)	21	11	12
Female	High	268	22	55.62 (.51)	0.56	2.23*	6.58*
Female	Low	271	21	55.06 (.48)		1.67	6.02*
Male	Low	70	11	53.39 (1.09)			4.35*
Male	High	63	12	49.04 (1.86)			

Note *p<.05**.**

Discussion

The three hypotheses have been strongly supported (see Table 3, 4, and 5) in this study. The results revealed that the PMS model was equally or even more important than the TPB and KAP models in explaining the COVID-19 preventive behaviors in family (HBF) of the Thai students (34.40%, 25.60%, and 20.20%, respectively). With increasing amount of predictive power of 9.10% the PMS model can be used to expand the TPB and the KAP models. More specifically, the two components from the PMS model, i.e., need achievement state, and internal locus of control, were found the two most powerful predictors of the target behavior in the total group as well as in the subgroups (Table 5). It may be due to the at-risk students who were mostly males with good grades (Table 7). This type of Thai students was low in their effort (ICC), had no preventive plan or strategy (nAchC) with less intention (BI) to prevent themselves from being infected with and transmitting the disease. The PMS model together with appropriate behavioral intention should be an important basis for COVID-19 prevention project.

Furthermore, the findings from MRA (Table 5) pinpointed that in general, and in most of the subgroups, nAchC was the most important predictor of HBF, followed by the ICC. In family, the traditional relaxing climate had long been set up. However, in the COVID-19 crisis, many new normal measures (e.g., wearing mask, frequently washing hands, social distancing) were requested to be enforced in the family. Thus, to follow these measures in the family which could be more difficult than in the public, one should have to put more effort (ICC) and to use more relevant techniques (nAchC). These findings supported the Protection-Motivation Theory (Orbell & Sheeran, 1998; Rad et al., 2021).

PBC and BI were also found as important predictors of HBF in total group and some subgroups (Table 5). This provided evidence to the supportive findings of the relationship between PBC and COVID-19 preventive behavior in previous studies (Aschwanden et al., 2021; Bronfman et al., 2021), as well as of the relationship between BI and COVID-19 preventive behavior (Rakotoarisoa et al., 2021). These findings pointed out that the more students perceived they had the ability to perform the preventive behavior and strong intention to perform

the behavior, the more they displayed that behavior. Hence, in order to increase the HBF in general, four psychological characteristics should be heightened, namely, nAchC, ICC, PBC, and BI. Furthermore, the study also found out that male students with high GPA were the at-risk group who should be trained on nAchC, ICC and BI in order to improve HBF. However, on the contrary, a Serbian study had found that age, but not gender, could differentiate students on their adjustment to school during the COVID-19 pandemic (Kavalić et al., 2021).

Recently, there have been an increase in studies on model comparisons. The purpose is to accelerate research production and review of academic body of knowledge, especially for coping with COVID-19 pandemic (Kazak, 2020; Smith & Gibson, 2020). The TPB model has been most often the candidate to compete or to be integrated with other antecedent models of behavior. In this study, after comparing the predictive power of the three models (Table 3), stepwise regression (Table 5) showed that in the total sample, as well as in female students, and students in nursing and public health, the important predictors of HBF were from all three models. In other words, nAchC and ICC predictors were more powerful prediction, and they were from the PMS model. The CE attitude predictor was from KAP model while PBC and BI predictors were from TPB model. These results supported all the hypotheses of the study.

The integration of predictors of health behavior from two or more models in this study was consistent with the results from many studies. For example, KAP and TPB models were integrated to predict oral health behavior of medical students from Romania (Dumitrescu et al., 2011). Another study from Sweden predicted pro-environmental behavior by integrating similar components from the KAP, TPB, and PMS models (Weimer et al., 2017). Unfortunately, only correlation coefficients and path coefficients were reported without the total magnitude of the predictors. Furthermore, a strong support of using locus of control as the distinct construct was confirmed in this study (Gulvin & Aboulafia, 2016).

Conclusion, Limitations and recommendations

The core focus in this study were predictors from three models, namely, Knowledge-Attitude-Practice model (KAP), Theory of Planned Behavior model (TPB), and Psycho-Moral Strength model (PMS) on health preventive behavior concerning COVID-19 in family context of undergraduate students. These three predictors were transformed as three research objectives of this study namely to to compare the magnitudes of associations between the psychological states and the preventive behavior from PMS Model with those from TPB and KAP models; to examine whether the PMS model can account for the variance of the target behavior beyond the KAP and the TPB models; and to to identify at-risk types of undergraduate students who showed less amount of preventive behaviors, and also to pinpoint the protective factors for future enhancement. This study concluded with the message that important, desirable, and sustainable behaviors were mostly consequences of many interlocking causal factors both internal and external to the actor. This study attempted and identified some important groups of internal or psychological characteristics of university students. These were goal setting, motivation, strategy to continue and sustain action, effort, as well as relevant knowledge, ability, and positive attitudes towards their behavior.

There were at least two important limitations of the study. First, only 15% of the students reported staying with family. This decreased the opportunity for preventive behavior in family (HBF). However, 40 more percent stayed with a friend or other people. A total of of 55 percentage of the total sample (N = 672) were considered the majority for data analyses. The second limitation was the somewhat incompatibility among the measures of the predictors and the behavior in some of the four domains (TACT; (Ajzen & Fishbein, 1977)). Most independent variables were broader on “context” (where) and “target” (to whom), than the measure of the dependent variable (HBF). However, 10 independent variables were more specific on the “action” of avoiding being at-risk of the disease, “time” during COVID-19 pandemic, and on the “actor,” the students in the sample. However, less than 10% of studies reviewed (Siegel et al., 2014) specified all components of the TACT domains. Thus, for greater

predictive powers, all the variables in the study should be constructed with higher compatibility. More importantly, the research design used in this study could not indicate any causal inference. Therefore, model integration should be encouraged to heighten the precision of predictions of important behaviors, such as disease prevention and pro-social behaviors. This can lead to more successful promotion of desirable behaviors in this era.

Future research can specify more necessary and sufficient causes for each type of at-risk individuals to achieve greater success of development. More experimental studies should be carried out to confirm the findings on COVID-19 preventive behavior in family of undergraduate students. They should consider different situational predictors e.g., cultural obligation, social support, and role model from significant others. Other important psychological characteristics that could affect health behavior also includes self-efficacy, which must also be included in future studies.

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