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Health Literacy, Health-Related Behaviors, and Stress Management as Modifiable Factors of Stress among University Students

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Background and Objective: Mental health among students in higher education remains a major public health concern, affecting well-being and academic performance. This survey research, conducted between December 2023 and January 2024, aimed to determine the academic stress and its related factors among 415 students [1st to 4th] in Nakhon Si Thammarat Rajabhat University, Thailand.

Materials and Methods: Participants were recruited using proportionate convenience sampling across faculties. The data were gathered through a structured questionnaire that consisted of five parts, including health literacy, health-related behaviors, stress management behaviors, and stress tests. Mean differences were compared using independent samples t-tests and one-way analyses of variance. Associations between variables were tested using Pearson correlation analysis. Multiple linear regression and structural equation modeling were used to examine factors associated with stress.

Result: The results revealed that about 70% students showed stress levels above the normal range. Furthermore, 13.73% of the students had stress at the highest severity level. Female students had significantly higher stress than males (p-value<.05), and fourth-year students exhibited significantly higher stress levels than first- and second-year students (p-value<.001). In addition, Science and Technology students experienced significantly less stress than other students (p-value=.004). Health literacy, health-related behavior, and stress management behavior were found to be significantly negatively correlated with stress. The findings were consistent with a potential mediating role of stress management in the association between health literacy and stress with health literacy showing significant indirect association with stress through stress management behaviors (p-value<.001).

Conclusion: These results revealed the importance of health literacy, health-related behavior, and stress management promotions among academic students to reduce stress. Interventions should be considered for specific student subgroups, including by sex, academic year, and faculty, to address those who might be at greater risk of stress.

Keywords: Health literacy; Health-Related Behavior; Stress Management Behavior; Stress

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Introduction

Student mental health in higher education is an ongoing and noteworthy issue worldwide, with a growing evidence base of the impact on student well-being and academic performance (1). Stress is considered an adaptive process that involves three closely related phases: the perception of a stressor, the experience of systemic imbalance manifesting as physiological or psychological symptoms, and the initiation of a response aimed at restoring homeostasis. This process consists of three basic factors: stimuli that cause stress, symptoms that indicate an imbalance, and coping strategies employed to manage stress (2).

Results of the University-Level Health Assessment Survey in Thailand, carried out from June to September 2022, revealed the magnitude of the mental health crisis faced by university students. Nearly 40% of the 9,050 respondents experienced high levels of stress. Furthermore, 4.3% had a clinical history of psychiatric disorders, including depression and bipolar disorder. Moreover, over 4% of students reported experiencing frequent to constant suicidal ideation, while 12% disclosed a history of self-harming behavior. Notably, 1.3% indicated that they were involved in self-harming frequently (3). This situation needs to understand the reasons behind students' psychological symptoms, establish how to prevent the adverse effects from stress.

Cognitive, behavioral, and mindfulness interventions are effective in reducing stress in university students (4). Multi-level approaches are required to enhance the mental health of student populations. The main recommendations are to make mental health services accessible in schools, tackle systemic socio-economic inequalities, promote digital health literacy, increase the standardization of mental health interventions, engage young people as co-designers of services, and encourage interdisciplinary research and collaboration (1). Health literacy, defined as the possession of literacy skills (reading and writing) and the ability to perform knowledge-based literacy tasks (acquiring, understanding, and using health information), was found to have a protective effect in reducing anxiety and stress among college students (5–7). Rosário et al., (2024) summarized 9 randomized controlled trial articles related in health literacy interventions in higher education students and found that those interventions contributed to positive changes in mental health, emotional, social, and psychological well-being (8). Mental health interventions can be categorized into four broad types: mindfulness and meditation-based practices; talking therapies such as individual or group-based psychological counseling; relaxation techniques including progressive muscle relaxation and controlled breathing; and mind-body training such as yoga and biofeedback interventions. Complementary to these interventions, lifestyle modifications are essential in promoting resilience to stress and enhancing immune defense (9). A systematic review and meta-analysis evaluated the efficacy of lifestyle interventions, for example, physical activity, dietary modifications, and sleep hygiene practices decreasing the symptoms of depression, anxiety, and stress (10). Health behavioral interventions, including dietary intake, physical

activity, alcohol use, and sleep in students in the university setting, can improve mental health (11). In addition, lifestyle changes that increase resilience to stress and enhance immune system defenses are indispensable, including adequate daily rest, a healthy diet, physical exercise, and the elimination of cigarette, drug, and alcohol use (12). Stress management interventions targeting the individual level using cognitive-behavioral therapy approaches, mindfulness-based interventions, relaxation techniques, including art therapy, emotional freedom techniques, and brief resilience retreats were effective in reducing levels of stress and anxiety (13). This study focused on modifiable factors, as previously mentioned, including health literacy, health-related behaviors, and stress management behaviors.

Mental health among students in higher education is influenced by a range of factors and requires multifaceted approaches for effective understanding and intervention. Results from the University-Level Health Assessment Survey in Thailand have highlighted the mental health concerns among university students (3); however, the survey did not identify the underlying or modifiable factors contributing to stress. To effectively address this issue, it is essential to determine the specific factors that might serve as potential contributors to student stress. Health literacy significantly influences health outcomes by enabling individuals to access, understand, evaluate, and use health information to make informed decisions and take actions that affect their health status (7). Guided by this perspective, the present study explores how health literacy may influence stress management and health-related behaviors among university students, which may in turn contribute to lower stress levels. At Nakhon Si Thammarat Rajabhat University, there is currently a lack of evidence reflecting the mental health status of students and the factors associated with mental health. To our knowledge, no previous study has simultaneously examined health literacy, health-related behaviors, and stress management behaviors as modifiable factors of stress among university students. The present study aims to examine the current mental health situation and identify factors associated with mental health status, particularly stress among undergraduate students at Nakhon Si Thammarat Rajabhat University. The findings from this research are intended to inform the development of mental health promotion strategies that would contribute to improving student well-being and enhanced academic performance.

Materials and Methods

This survey research was carried out at the Nakhon Si Thammarat Rajabhat University between December 2023 and January 2024.

Population, sample and sampling method

The population consisted of all undergraduate students enrolled at Nakhon Si Thammarat Rajabhat University. The sample size was calculated using the formula proposed by Serdar et al. (2020)(14)

$$n = \frac{Z_{\frac{\alpha}{2}}^2 \times P \times (1-P)}{E^2}$$

Since the exact prevalence (P) of stress among university students was unknown, a conservative estimate of 0.5 was used to ensure the maximum sample size. The margin of error (E) was set at 5% with a 95% confidence level, resulting in a required sample size of 385 participants. To allow for possible missing data, an additional 30 participants were included, resulting in an overall sample of 415 students. To ensure proportional representation, the ratio of the sample size (415) to the total student population (5,955, as recorded on March 24, 2023) was applied to each faculty to determine the number of participants to be selected from each. Participants were undergraduate students in years 1 to 4 who voluntarily agreed to participate and were recruited using proportionate convenience sampling across faculties.

Instrument descriptions

Data was collected using a structured questionnaire containing information on five parts as outlined below:

Part 1: General information: This included students' sex, religion, year of study, their current faculty, and body mass index (BMI).

Part 2: Thai Health Literacy Questionnaire (THL-Q): This section utilized the Thai Health Literacy Questionnaire (THL-Q) developed by the Bureau of Health Promotion, Department of Health, Ministry of Public Health of Thailand. The questionnaire was 24 questions long and covered six domains: access to health information and services (e.g., Can you access information about health care or disease prevention when needed?) (questions 1–4), understanding of sufficient health information and services for practice (e.g., Are you able to read, understand, and follow instructions provided in manuals, documents, brochures, or posters related to health care and disease prevention?) (questions 5–8), engagement with questions to gain knowledge and understanding (e.g., Can you ask health-care providers for health information to improve your self-care?) (questions 9–12), the ability to make quality decisions (e.g., Do you use reason to weigh the advantages and disadvantages of health information you receive, even when others report positive results, before applying it yourself?) (questions 13–16), changing self-health behavior (e.g., Can you plan activities necessary to maintain good health?) (questions 17–20) and information sharing (e.g., Can you serve as a role model for others by demonstrating the importance of maintaining good self-care?) (questions 21–24). The THL-Q assessed the degree of actual experience using a 5-point Likert scale, with response options ranging from "Very High", "High", "Moderate", "Low", to "Very Low", scored from 5 to 1, respectively.

Part 3: Health-related Behavior Assessment: A 5-point Likert scale was used for this section which consisted of three components: dietary behavior (questions 1–5), physical activity (questions 6–7), and smoking and alcohol consumption (questions 8–10). These behaviors were measured in terms of practice frequency (average number of days per week) as "6–7 days", "4–5 days", "3 days", "1–2 days", and "Never practiced", scored 4 to 0, respectively. Items with negative phrasing were recoded before scoring to preserve alignment of interpretation of the overall scores.

Part 4: Stress Management Assessment: This section adapted a 20-item stress management questionnaire from Boonpume (2010)(15), employing a 4-point Likert scale to evaluate the frequency of stress management behaviors. The response options included "Regularly", "Sometimes", "Rarely", and "Never", with corresponding scores from 3 to 0. Reverse scoring was applied to negatively worded items to ensure that higher scores consistently reflected more effective stress management behaviors.

Part 5: Stress Test (ST-20): This part employed the Stress Test-20 (ST-20) scale, which was developed by the Division of Mental Health Promotion and Development, Department of Mental Health, Ministry of Public Health of Thailand. It included 20 items and measured the occurrence of stress-related symptoms on a 4-point Likert scale: “regularly” (5–7 days a week), “often” (3–4 days a week), “sometimes” (1–2 days a week), and “never” with scores between 3 and 0, respectively. The interpretation criteria for stress scores were categorized as follows: scores ranging from 0 to 5 indicated a stress level lower than normal; 6 to 17 reflected a normal stress level; 18 to 25 indicated a slightly elevated stress level; 26 to 29 represented a moderately elevated stress level; and scores between 30 and 60 signified a significantly elevated stress level.

Instrument validation and reliability testing

The questionnaire was reviewed by three experts in the fields of mental health behavior to evaluate its content validity. The validity was assessed using the Item-Objective Congruence (IOC) index, yielding a score of 0.99, indicating a high level of agreement among the experts. Following this, the revised questionnaire was pilot-tested with a group of 30 individuals possessing characteristics similar to those of the target sample. The reliability of Sections 2 to 5 of the questionnaire was evaluated using Cronbach’s alpha coefficient. The results demonstrated high internal consistency, with Cronbach’s alpha values of .965 for the Thai Health Literacy Questionnaire, .812 for the Health-related Behavior Assessment, .922 for the Stress Management Assessment, and .950 for the Stress Test.

Data collection procedures

After obtaining approval from the Human Research Ethics Committee, data were collected by recruiting students from various areas within each faculty using proportionate convenience sampling. Prior to the involvement of the study, the aim and essential information of the study were well explained to students to ensure their willingness to participate in the study. After obtaining informed consent, the questionnaire was distributed to the participants to be individually fulfilled by them. Students from the Faculties of Education, Science and Technology, Humanities and Social Sciences, Management Science, and Industrial Technology were recruited until the required proportionate sample size calculated for each faculty was achieved. The obtained questionnaires were then cross-checked for completeness and accuracy and then subjected to statistical analysis.

Data analysis

Participant characteristics were described by descriptive statistics, including frequency, mean, and standard deviation. Independent sample t-tests were used to test the mean

differences between the dependent variables and the independent variables, which consisted of two levels, such as gender, religion, and underlying disease. One-way analyses of variance (ANOVA) were used to test mean differences between the dependent variables and the independent variables, which consisted of at least three levels, including year of study, faculty, and body mass index. Pearson correlation was run to assess the association between stress levels and health literacy, health-related behavior, and stress management. In addition, multiple linear regression was run to test the relationship between multiple independent variables and the dependent variable in order to identify the significant predictors. An alpha level of p-value < 0.05 was set to test statistical significance in all analyses. Data were analyzed using PSPP, an open-source and free statistical software (16).

Structural equation modeling (SEM) was conducted to examine the hypothesized relationships among health literacy, health behavior, stress management, and stress using JASP (Version 0.96) (17) (JASP Team, 2026). The analysis was performed using robust maximum likelihood estimation (MLR) to account for potential non-normality, as indicated by significant multivariate skewness and kurtosis (Mardia's test, $p < .001$). Missing data were handled using full information maximum likelihood (FIML). Indirect effects were evaluated using bootstrapping with 5,000 resamples to obtain bias-corrected 95% confidence intervals. Standardized estimates were reported for all model parameters. Model fit was assessed using multiple fit indices, including the comparative fit index (CFI), Tucker–Lewis index (TLI), and standardized root mean square residual (SRMR).

Results

Student stress and characteristics

All 415 participants completed the questionnaire and no attrition occurred. Approximately 70% reported stress levels above the normal range, with 13.73% classified at the highest severity level **(Table 1).** Participant characteristics are summarized in Table 2; most participants were female, Buddhist, having no underlying medical conditions. Students were recruited across faculties according to proportionate sample allocation **(Table 2).**

Table 1- Distribution of student stress levels by stress severity categories (n = 415)

Stress levels	Number	Percentage
Lower than normal stress	34	8.20
Normal stress	79	19.04
Slightly elevated stress	169	40.72
Moderately elevated stress	76	18.31
Significantly elevated stress	57	13.73

Differences in stress across student characteristics and possible contributing factors

The results of the independent samples t-test indicated that female students reported significantly higher mean stress scores than male students with a statistically significant difference (p-value = .01). In contrast, no significant differences in stress levels were found between students of different religions or between those with and without underlying

medical conditions **(Table 2).** The health literacy, health-related behavior, and stress management between female and male students were analyzed by independent samples t-test to explore possible contributing factors. The results showed that female students reported significantly lower health literacy than male students with a statistically significant difference (p-value = .002) (Table 3)

A one-way analysis of variance (ANOVA) revealed a statistically significant difference in stress levels across academic years (p-value<.001). LSD post hoc comparisons indicated that there was no significant difference in stress levels between first- and second-year students. However, fourth-year students exhibited significantly higher stress levels than first- year students and second-year students, with p-values of .004 and <.001, respectively (Table 2). To explore possible factors underlying the higher stress observed among fourth-year students, post hoc LSD tests following ANOVA showed that health literacy among fourth-year students was significantly lower than that of first- and second-year students (Table 3). Furthermore, statistically significant differences in stress levels were observed across faculties (p-value=.004). LSD post hoc tests revealed that students in the Faculty of Science and Technology had significantly lower stress levels compared to students in the Faculty of Education (p-value=.009), Faculty of Humanities and Social Sciences (p-value = .004), Faculty of Management Science (p-value<.001), and Faculty of Industrial Technology (p-value = .006). However, no significant differences in stress levels were found when categorized by BMI levels (Table 2). To examine possible factors contributing to differences in stress across faculties, post hoc analysis using the LSD test showed that students in this faculty also had significantly higher stress management scores compared to those in other faculties **(Table 3).**

Table 2- A mean comparison of stress levels across different student characteristics (n = 415)

Variables	Number (%)	Mean	SD	P-value
Sex				
Female	321 (77.35)	21.95	8.33	.010*
Male	94 (22.65)	18.86	10.61	
Religion				
Buddhism	372 (89.64)	21.39	8.86	.353
Islam	43 (10.36)	20.05	10.01	
Year of study				
1st	119 (28.67)	20.06	10.95	<.001**
2nd	51 (12.29)	17.65	10.99	
3rd	65 (15.66)	21.25	9.55	
4th	180 (43.37)	23.07	5.76	
Faculty				
Education	133 (32.05)	21.02	9.47	.004**
Science and Technology	42 (10.12)	16.88	6.99	
Humanities and Social Sciences	123 (29.64)	21.48	10.50	
Management Science	58 (13.98)	23.86	3.53	
Industrial Technology	59 (14.22)	21.85	8.46	
Body mass index				

< 18.5	58 (13.98)	21.03	9.55	.174
18.5-22.9	217 (52.29)	20.87	9.11	
23-24.9	67 (16.14)	23.39	6.82	
25-29.9	48 (11.57)	21.63	8.48	
>29.9	25 (6.02)	18.68	11.73	
Underlying disease				
No	400 (96.39)	21.13	8.83	.318
Yes	15 (3.61)	24.47	12.36	

* and ** representing the statistical significance at the P-value < 0.05 and < 0.01, respectively

Table 3- Mean comparisons of health literacy, health-related behavior, and stress management behavior across different student characteristics (n=415)

Variables	Health Literacy			Health-Related Behavior			Stress Management Behavior		
	Mean	SD	P-value	Mean	SD	P-value	Mean	SD	P-value
Gender									
Female	87.87	16.39	**.002**	23.73	3.57	.213	33.64	6.40	.692
Male	92.78	12.36		23.04	4.98		33.35	5.37	
Religion									
Buddhism	88.69	15.87	.277	23.54	3.99	.617	33.29	5.97	.023
Islam	91.44	13.91		23.86	3.47		36.02	7.38	
Year of study									
1st	95.70	11.15	**<.001**	23.37	4.31	.479	32.82	5.50	.000
2nd	95.49	12.50		24.37	4.48		37.61	7.24	
3rd	90.95	15.64		23.49	4.01		34.92	8.03	
4th	81.98	16.23		23.52	3.46		32.43	4.86	
Faculty									
Education	86.42	16.81	<.001	23.61	4.03	.007	33.91	6.44	**<.001**
Science and Technology	88.71	15.97		24.62	3.93		37.24	7.78	
Humanities and Social Sciences	95.97	11.32		23.40	4.32		33.94	6.39	
Management Science	73.05	12.83		22.17	2.22		30.12	2.41	
Industrial Technology	96.02	8.94		24.51	3.84		32.81	4.54	
Body mass index									
< 18.5	93.62	15.71	.003	25.10	4.16	.020	33.60	7.37	.071
18.5-22.9	88.37	15.91		23.14	4.03		34.02	6.17	
23-24.9	83.85	15.51		23.54	3.59		32.42	5.29	
25-29.9	90.42	13.54		23.79	3.80		32.10	4.66	
>29.9	94.44	14.02		23.48	2.82		35.48	7.29	
Underlying disease									
No	88.93	15.76	.746	23.50	3.90	.050	33.41	6.12	.007
Yes	90.27	14.23		25.53	4.42		37.80	6.48	

Correlations among health literacy, behaviors, and stress

Table 4 showed the Pearson correlation coefficients (r) and corresponding p-values to test the relationship between stress levels and various factors, including health literacy, health-related behavior, and stress management behavior in academic students. Overall health literacy was found to have a significant negative correlation with stress levels (r=–.285, p-

value<.001), indicating that higher health literacy was associated with lower stress. All dimensions of health literacy demonstrated statistically significant negative correlations with stress levels, suggesting that students with higher level of health literacy were likely to report a lower level of stress. Overall health-related behavior also showed a significant inverse relationship with stress (r=–.287, p-value<.001). These results suggest that healthier behaviors, including eating well, exercising regularly, and smoking and drinking less were significantly associated with lower levels of stress. Stress management behaviors exhibited the strongest negative correlation with stress levels (r=–.443, p-value<.001), suggesting that adequate stress management was an important protective factor against high stress.

Table 4- Factors related to stress levels among academic students

Variables	r	P-value
Health Literacy	**-.285****	**<.001**
- Access to health information and services	-.237**	<.001
- Understanding adequate health information and services for practice	-.270**	<.001
- Interacting with questions to increase knowledge and understanding	-.246**	<.001
- Making quality decisions	-.253**	<.001
- Changing one's own health behavior	-.261**	<.001
- Sharing health information	-.208**	<.001
Health-Related Behavior	**-.287****	**<.001**
- Dietary behavior	-.251**	<.001
- Physical activity	-.139**	.005
- Smoking	-.132**	.007
- Alcohol consumption	-.107*	.029
Stress Management	**-.443****	**<.001**

** representing the statistical significance at the P-value < 0.01

Regression/SEM analyses of associations and estimated indirect pathways

Multiple linear regression was used to test the association between stress and the independent variables. Dummy variables were created for categorical variables with more than two levels. The final model was significant compared with the constant (F=15.82; p-value<.001). Significant associated factors of stress were health-related behavior, stress management behavior, female (ref=male), Faculty of Science and Technology (ref=non-Science and Technology) and having an underlying disease. R^2 and adjusted R^2 of the model were 0.28 and 0.26, respectively **(Table 5).**

The structural model was just-identified (df=0), resulting in a non-significant chi-square statistic (χ^2=0, p-value=1.00). Because the structural model was just-identified (df=0), the fit indices (CFI=1.00, TLI=1.00, and SRMR<.001) reflected perfect fit by definition and therefore were not informative for evaluating model adequacy. Accordingly, interpretation of the SEM results focused primarily on the estimated path coefficients and indirect effects rather than the overall model fit. Health literacy was positively associated with both health-related

behavior (β=0.272, p-value<.001) and stress management (β=0.348, p-value<.001). Both mediators were significantly associated with stress **(Table 6).** Health-related behavior was negatively associated with stress (β=-0.119, p-value=.017), whereas stress management demonstrated a stronger negative effect (β=-0.353, p-value<.001). A direct association between health literacy and stress remained significant (β=-0.129, p-value=.005) **(Table 6),** suggesting that higher health literacy was related to lower stress levels independent of the mediators. Significant indirect effects of health literacy on stress were observed through both mediators. The indirect effect via health-related behavior was small but significant (β=-0.032, p-value=.036), whereas the indirect effect via stress management was larger and highly significant (β=-0.123, p-value<.001) **(Table 7).** The total indirect effect was significant (β=-0.155, p-value<.001), and the total effect of health literacy on stress was also significant (β=-0.285, p-value<.001) **(Table 7).** These findings were consistent with a parallel partial mediation model, with stress management representing the stronger pathway **(Figure 1).**

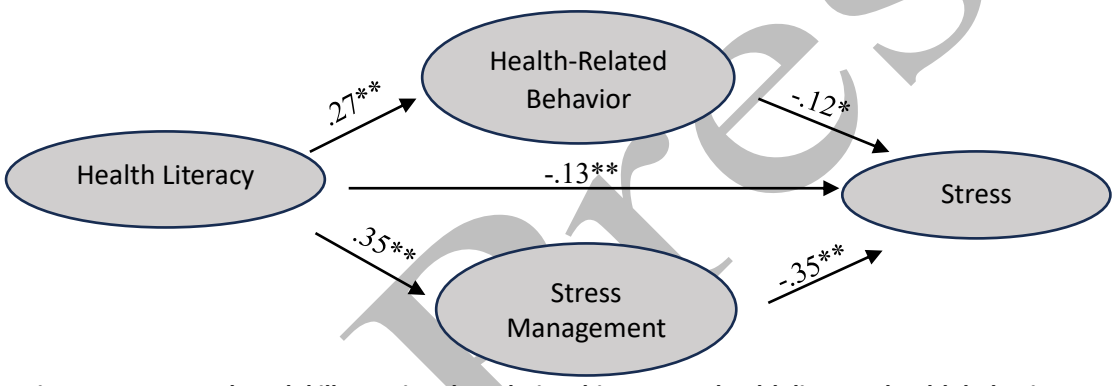

Figure 1- Structural model illustrating the relationships among health literacy, health behavior, stress management, and stress
(* and representing the statistical significance at the p-value < 0.05 and 0.01, respectively)**

Table 5- Factors predicted stress levels among academic students analyzed by multiple linear regression

Model	Unstandardized coefficients		Standardized coefficients		
	B	Std. error	*β*	*t*	P-value
Constant	34.44	9.73		3.54	<.001
Health Literacy	-.04	.03	-0.7	-1.34	.182
Health-related behavior	-.33	.11	-.14	-3.05	.002
Stress Management behavior	-.52	.07	-.36	-7.35	<.001
Age	.71	.44	.12	1.64	.102
BMI	-.03	.09	-.01	-.28	.782
Female (ref-male)	2.70	.95	.13	2.84	.005
Buddhism (ref- Islam)	-.44	1.30	-.01	-.34	.736
4^{th} years of study (ref-non-4^{th} years)	-.39	1.30	-.02	-.03	.766
Faculty of Science and Technology (ref- non-Science and Technology)	-3.00	1.33	-.10	-.30	.025
Underlying disease (ref-No)	6.00	2.07	.12	2.90	.004

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Table 6- Standardized path coefficients linking health literacy, health behavior, stress management, and stress

Dependent Variable	Predictor	β	SE	z-value	p-value
Stress	Health Literacy	-.129	.046	-2.838	.006
	Health-Related Behavior	-.119	.050	-2.387	.017
	Stress Management	-.353	.059	-6.013	<.001
Health-Related Behavior	Health Literacy	.272	.045	6.011	<.001
Stress Management	Health Literacy	.348	.041	8.540	<.001

Note. β and SE represent standardized regression coefficient and standard error, respectively.
R^2 (Stress) = .23; R^2 (Health-Related Behavior) = .07; and R^2 (Stress Management) = .12

Table 7- Mediation effects of health literacy on stress

Effects	β	SE	z-value	p-value
Health Literacy → Health-Related Behavior → Stress	-.032	.015	-2.098	.036
Health Literacy → Stress Management → Stress	-.123	.026	-4.638	< .001
Total indirect	-.155	.027	-5.701	< .001
Direct effect	-.129	.046	-2.838	.006
Total effect	-.285	.038	-7.511	< .001

Note. β and SE represent standardized regression coefficient and standard error, respectively.

Discussion

The present study revealed that about 70% students showed stress levels above the normal range. Furthermore, 13.73% of the students had stress at the highest severity level. This proportion was lower than that reported in the University-Level Health Assessment Survey in Thailand, where nearly 40% of respondents experienced high stress (3). Multiple factors contribute to mental health in undergraduate students, including physical illness or disability such as injuries or chronic conditions present at baseline; psychological variables including self-esteem, emotional regulation, self-perceived health status, stress, and cognitive functioning; trauma-related predictors including exposure to adverse childhood experiences and sexual victimization; familial and relational factors particularly parental physical or

mental health conditions; sociodemographic variables such as gender and financial hardship; and lifestyle factors including smoking, alcohol and drug use, and dietary habits (18). Variation in stress-related factors may explain differences in stress levels across populations.

This study identified several factors associated with stress among university students. Female students were found to have significantly higher stress scores compared to their male counterparts. Emmerton et al. (2024) showed that females had significantly higher averages of depression, anxiety, and stress than males (19). Prior studies have reported that males typically exhibit a more pronounced acute response from the hypothalamic-pituitary-adrenal (HPA) axis, such as increased cortisol secretion and stronger autonomic nervous system activation in response to standard performance-related psychosocial stressors (20). In contrast, female sex hormones have been shown to attenuate HPA axis responsiveness, resulting in slower cortisol feedback to the brain and delayed regulation of the stress response. Furthermore, women have demonstrated greater sensitivity to the depressogenic effects of interpersonal problems, which may exacerbate stress levels. Gender differences in stress responses are also characterized by distinct behavioral patterns: the "fight-or-flight" response is more commonly observed in men, while women tend to exhibit a "tend-and-befriend" pattern of response (20). In the present study, female students also demonstrated significantly lower levels of health literacy compared to male students. Previous research suggests that health literacy plays a protective role in mitigating anxiety and stress among college students (5).

There was no statistically significant difference in stress levels between first- and second-year students. However, fourth-year students exhibited significantly higher stress levels compared to first- and second-year students. These findings are consistent with previous research indicating that upperclassmen tend to experience higher levels of stress, anxiety, and depression than freshmen and sophomores (21). Among final-year students, common sources of stress include academic workload, societal expectations, and uncertainty regarding future careers (22). In the present study, LSD post hoc tests following ANOVA revealed that the health literacy of fourth-year students was statistically significantly lower than that of first- and second-year students. This suggests that lower levels of health literacy may contribute to the elevated stress observed in upper-year students.

Students from the Faculty of Science and Technology demonstrated significantly lower stress compared to their peers in other faculties. Consistent with previous findings, students in science-related disciplines, including those in the Faculties of Science and Medicine, were found to report the lowest levels of stress, while students in the Faculty of Information Technology exhibited the highest stress levels (23). In the present study, the results of the ANOVA revealed that students in the Faculty of Science and Technology also exhibited significantly higher levels of stress management compared to students from other faculties. This finding highlights the potential role of effective stress management in mitigating stress.

A growing body of evidence supports the effectiveness of structured stress management programs in enhancing university students' mental health and coping abilities (24).

Health literacy was found to be significantly negatively correlated with stress, indicating that higher levels of health literacy were associated with lower stress levels among university students. Rababah et al. (2020) reported that health literacy had a protective effect against three major psychological disturbances in college students, namely, perceived stress, depressive symptoms, and impulsivity (25). Similarly, Ying et al. (2022) emphasized that health literacy plays a critical role in reducing anxiety and stress, and consequently recommended the implementation of campus-based health education programs aimed at enhancing both health literacy and mental well-being (5). Furthermore, individuals with limited health literacy are less likely to use preventive health services, have difficulties managing chronic health conditions, are less adherent to healthcare provider instructions, experience negative psychological outcomes, have a diminished ability to respond to public health alerts, and are more likely to self-rate their health as fair or poor (26). A systematic review of nine randomized controlled trials involving university students showed that health literacy interventions improved mental health, well-being, health behaviors, and self-efficacy, supporting their role in promoting student health and preventing adverse outcomes (8). These findings underscore the importance of integrating health literacy promotion into university mental health strategies.

Positive health-related behaviors were associated with lower levels of stress, supporting the role of lifestyle factors in enhancing psychological resilience. Streram et al. (2025) summarized that health behavioral interventions, including dietary intake, physical activity, alcohol use, and sleep can improve mental health in university students (11). Engaging in healthy dietary practices has been shown to contribute significantly to stress management. Essential nutrients, including multivitamins and minerals such as vitamins E, B1, B2, B3, B5, B6, B12, and C, as well as folic acid, zinc, and iron, are considered anti-stress agents. Conversely, insufficient intake of omega-3 fatty acids, critical for optimal brain function, has been linked to disruptions in neurotransmission and the onset of various psychiatric disorders. Physical activity also plays a key role in stress reduction, as it enhances the body's capacity to regulate stress through hormonal modulation. Exercise stimulates the release of neurotransmitters such as dopamine and serotonin, which are known to positively influence mood, emotional regulation, and behavioral responses. Moreover, the avoidance of harmful behaviors such as smoking, drug use, and excessive alcohol consumption has been identified as a protective factor against stress (12).

Stress management was found to be negatively associated with stress levels, indicating that individuals who engage in effective stress management behaviors tend to experience lower psychological stress. Interventions aimed at improving stress management have also been shown to positively influence cortisol levels, a key biomarker of physiological stress. According

to Rogerson et al. (2024), stress management interventions could be classified into four primary categories: (1) talking therapies, which involve psychological interventions delivered in one-on-one, group, or online formats; (2) mindfulness and meditation, encompassing mindfulness-based therapies and meditation practices; (3) relaxation techniques, including muscle relaxation, breathing exercises, and biofeedback-assisted relaxation; and (4) mind-body training, such as yoga and biofeedback exercises (9). Catapano et al. (2023) demonstrated that individual-level stress management interventions, including cognitive-behavioral therapy, mindfulness-based approaches, relaxation techniques, art therapy, emotional freedom techniques, and brief resilience retreats can effectively reduce stress and anxiety (13). Furthermore, cognitive, behavioral, and mindfulness-based interventions have demonstrated effectiveness in reducing stress among university students. These findings underscore the importance of implementing structured stress management programs in higher education settings, with the goal of enhancing student well-being and academic performance (4).

The findings were consistent with a potential mediating role of stress management in the relationship between health literacy and stress. The results suggest that stress management may serve as an important pathway linking health literacy to stress. Although the direct association between health literacy and stress was relatively modest, the indirect association through stress management accounted for a substantial proportion of the total effect. This suggests that health literacy might reduce stress primarily by enabling students to adopt more effective stress management strategies rather than by directly lowering stress levels. This finding is consistent with health literacy frameworks (7), which emphasize that the benefits of health literacy are often realized through behavioral pathways. Students with higher health literacy might be better able to access, understand, and apply stress-related information, allowing them to select appropriate coping strategies, regulate their emotions, and respond more adaptively to academic and psychosocial stressors. Health literacy improvement program could increase stress management in older adults with type 2 diabetes and hypertension comorbidities (27). Nursing students participated in mental health literacy enhancement program was able to increases the mental health status (28). The college students' mental health literacy and psychological resilience are strongly linked to anxiety. Interestingly, psychological resilience plays a significant mediating role in the relationship between mental health literacy and anxiety levels (29). The model explained 23% of the variance in stress (Table 6), 77% of the variance remained unexplained, indicating that additional unmeasured factors may influence student stress. Interestingly, health literacy was not a statistically significant predictor in the multiple linear regression model, whereas it showed a significant direct association with stress in the SEM analysis. This apparent discrepancy may reflect differences in the analytical frameworks. Multiple linear regression estimates direct associations while controlling for all predictors simultaneously, which may reduce the apparent independent contribution of health literacy because of shared variance

among related predictors. In contrast, SEM simultaneously estimates both direct and indirect pathways (30), allowing the mediating mechanisms linking health literacy and stress to be more clearly represented.

Study Limitations and Strengths: There are several limitations associated with this study. First, the cross-sectional nature of the study means that no causal link can be drawn between health literacy, health behavior, stress management, and stress. Second, the sample used in this study was recruited through proportionate convenience sampling, which could have resulted in selection bias. Students who were present, accessible, and willing to participate in the study might differ from those who were absent and not willing to join the study. Students under high levels of stress would opt out of participating in the study. Another limitation concerns the structural equation model specification. The hypothesized model was just-identified (df=0) indicating that the number of estimated parameters equaled the number of observed variances and covariances. As a result, conventional model fit indices such as CFI, TLI, and SRMR were not informative indicators of model adequacy because a just-identified model will always demonstrate perfect fit mathematically. Therefore, the SEM findings should be interpreted cautiously and primarily as evidence supporting the plausibility of the proposed relationships rather than confirmation of an optimal model structure. Future studies should consider testing over-identified models with additional theoretically relevant variables or latent constructs to allow more rigorous evaluation of model fit.

Conclusion

All variables analyzed, health literacy, health-related behavior, and stress management, were significantly negatively correlated with stress. This suggests that improving students' health literacy and promoting healthy behaviors and stress management strategies may effectively reduce stress levels in academic settings. Targeted interventions should be considered for specific student subgroups, including by gender, academic year, and faculty, to address those who might be at greater risk of experiencing elevated stress.

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