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Emotion regulation, academic resilience, and perceived stress in health professions students: a cross-sectional analysis of indirect associations

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Background: Health professions students face substantial academic and clinical demands that may increase perceived stress. Previous studies have examined emotion regulation and academic resilience separately, but little is known about whether academic resilience is related to the association between emotion regulation and perceived stress. Academic resilience was examined because students who regulate their emotions more effectively may be better able to cope with academic difficulties, and greater resilience may in turn be associated with lower perceived stress. This study examined the associations of emotion regulation with academic resilience and perceived stress, as well as their indirect associations with perceived stress through academic resilience.
Methods: A cross-sectional study was conducted among 180 health professions students recruited from a medical university in Taiwan using convenience sampling. Participants completed measures of emotion regulation, academic resilience, and perceived stress. Cognitive reappraisal and expressive suppression were analyzed separately. Pearson correlation analyses and PROCESS Model 4 were used to examine the proposed associations and statistical indirect associations.
Results: Cognitive reappraisal was positively associated with academic resilience (B = 1.04, $p < .001$), whereas expressive suppression was not significantly associated with academic resilience (B = −0.14, $p = .402$). Academic resilience was negatively associated with perceived stress in the cognitive reappraisal model (B = −0.15, $p < .001$). The statistical indirect association between cognitive reappraisal and perceived stress through academic resilience was significant (effect = −0.16, 95% percentile bootstrap CI [−0.24, −0.07]), whereas the corresponding indirect association for expressive suppression was not significant (effect = 0.02, 95% percentile bootstrap CI [−0.04, 0.10]).

Conclusion: Cognitive reappraisal was positively associated with academic resilience and showed a significant statistical indirect association with perceived stress through academic resilience, whereas expressive suppression showed no significant indirect association. These findings suggest that different emotion regulation strategies may have different associations with academic resilience and perceived stress. However, because participants were recruited by convenience sampling from a single university, the findings may not be generalizable to students in other institutions or settings. Longitudinal and multi-institutional studies are needed to further examine these associations.

KEYWORDS

academic resilience, cognitive reappraisal, emotion regulation, expressive suppression, health professions students, perceived stress

1 Introduction

Health professions students face intensive academic demands, frequent examinations, substantial workloads, and increasing clinical responsibilities. These demands can place considerable pressure on students' psychological well-being and require continuous support and adaptation throughout the professional training (1, 2). Recent studies have shown that perceived stress remains an important concern among both medical and nursing students, particularly when academic expectations and performance evaluation are combined with clinical responsibilities (3–5). Identifying psychological resources associated with more adaptive responses to these demands is therefore important for understanding and supporting the mental health of health professions students.

Emotion regulation is one such psychological resource. It refers to processes through which individuals influence the experience, expression, and management of emotional responses (6, 7). The ability to regulate emotional responses may be particularly relevant in health professions education, where students encounter academic pressure alongside interpersonal and clinical challenges (8). Recent evidence has increasingly linked emotion regulation with stress-related and mental health outcomes in university populations (9). Emotion regulation has been identified as an important psychological process associated with stress and depressive symptoms among undergraduate students (10). Among medical students, adaptive emotion regulation has also been associated with lower burnout within mediation models (11). Similarly, research involving university students has demonstrated that emotion regulation strategies are relevant to the association between academic stressors and health-related outcomes (12). These findings suggest that emotion regulation may be an important component of psychological adaptation to demanding educational environments.

Academic resilience may represent another important resource in this process. From a resilience perspective, adaptive functioning under conditions of adversity reflects the interaction of individual and contextual protective resources (13). Unlike broader conceptualizations of psychological resilience, academic resilience specifically concerns students' capacity to respond adaptively to academic adversity, setbacks, and sustained educational demands (14). It may therefore be particularly salient for health professions students, whose training requires persistence and adaptation across both academic and clinical settings. Academic resilience has been shown to be associated with students' adaptive characteristics and their capacity to manage demanding academic environments (15, 16). Recent cross-national evidence involving 1,833 university students showed that greater academic resilience was associated with lower perceived stress, while emotional resources were positively associated with resilience (17). Resilience-related processes have also received increasing attention in medical education. Psychological resilience has also been found to be involved in significant indirect associations between academic stress and test anxiety among medical students (18). This evidence highlights the potential relevance of resilience as a psychological resource in stressful academic environments.

Although emotion regulation, resilience, and perceived stress have each been studied in student populations, few studies have examined how these three factors are related within the same model in health professions students. Recent studies have examined emotion regulation as an intermediary psychological process in relation to stress, burnout, and mental health outcomes (10, 11), whereas other studies have emphasized the association of resilience with academic stress and psychological adjustment (17, 18). In particular, few studies have examined whether academic resilience is involved in the statistical association between emotion regulation and perceived stress among students from different health professions. Based on the above evidence, health professions students who manage their emotional responses more effectively may also show greater academic resilience when facing academic difficulties. Greater academic resilience has been associated with lower perceived stress (17). These findings provide a basis for examining whether academic resilience is statistically involved in the association between emotion regulation and perceived stress. Examining this relationship may help clarify how emotion-related psychological resources and academic adaptation are interconnected within demanding professional education.

Accordingly, the present study examined the associations of emotion regulation (including cognitive reappraisal and expressive suppression) with academic resilience and perceived stress among health professions students at a medical university in Taiwan. We hypothesized that (1) emotion regulation would be positively associated with academic resilience and negatively associated with perceived stress; (2) academic resilience would

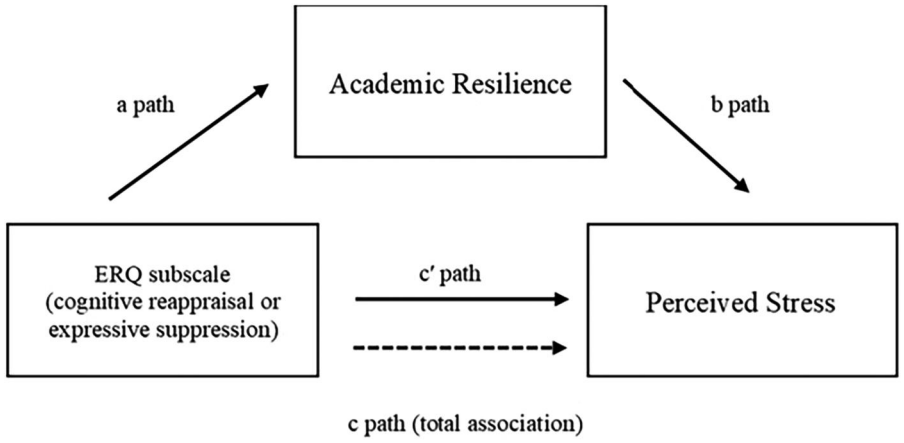


FIGURE 1
Statistical indirect association model. Cognitive reappraisal and expressive suppression were examined separately as X, with academic resilience as M and perceived stress as Y. The cross-sectional model does not imply causal mediation.

be negatively associated with perceived stress; and (3) there would be a significant statistical indirect association between emotion regulation and perceived stress through academic resilience (Figure 1). In addition, cognitive reappraisal and expressive suppression were examined separately as distinct emotion regulation strategies in relation to academic resilience and perceived stress. Given the cross-sectional design, the proposed models were interpreted as statistical models of indirect associations rather than evidence of temporal or causal mediation.

2 Materials and methods

2.1 Study design and setting

A cross-sectional study was conducted among health professions students at a medical university in northern Taiwan. The participating institution is a medical university offering several health professions programs, including medicine, dentistry, pharmacy, nursing, and public health. The educational setting includes students from several health professions and different stages of professional training. Data were collected in February 2022 during the academic semester. The study examined the associations of cognitive reappraisal and expressive suppression with academic resilience and perceived stress and evaluated their statistical indirect associations with perceived stress through academic resilience.

2.2 Participants and recruitment

Participants were recruited using convenience sampling. This sampling approach was used because recruitment was conducted within the participating university during the study period, and eligible students who were available were invited to participate. Students were eligible to participate if they (1) were aged 18–26 years, (2) were enrolled in a health professions program at the participating medical university, (3) had completed at least one semester of study, and (4) were willing to participate and complete the questionnaire at the designated time. Students were excluded if they self-reported (1) a physician-diagnosed psychiatric disorder, such as schizophrenia or depression; (2) cognitive impairment or a sleep disorder; (3) a severe physical illness requiring ongoing treatment; (4) current smoking, alcohol misuse, or substance use; or (5) current use of medications known to affect perceived stress or emotional responses. These exclusion criteria were applied to reduce potential confounding from health conditions, substance use, and medications that could independently influence emotional responses and perceived stress. Among the 210 students who were approached, 30 declined to participate and 180 completed the questionnaire, yielding a response rate of 85.7% among those approached. Because a university-wide sampling frame was not used, the total number of eligible students across the university was not available. To assess the adequacy of the sample size for the primary regression model, a power analysis was conducted using G*Power 3.1.9.7. Based on a multiple regression model with two predictors, a medium effect size ($f^2 = 0.15$), $\alpha = .05$, and a power of.80, the minimum required sample size was 68 participants. The final sample of 180 participants was larger than this estimated minimum.

2.3 Data collection procedure

Data were collected during the third and fourth weeks of February 2022. Before data collection, the research team reviewed the questionnaires for clarity and appropriateness. The first author converted the questionnaires into an electronic format, and the principal investigator trained the research team to ensure consistency in explaining the study, providing instructions, and administering the questionnaires.

Eligible students were approached once before or after class and invited to participate in the study. Students decided at that time whether they wished to participate; no additional reminders were provided. Those who agreed to participate were

directed to a designated classroom, where the first author explained the study purpose, procedures, voluntary nature of participation, and potential risks and benefits. After providing written informed consent, participants completed the electronic questionnaire using their mobile devices in a quiet area near the classroom. Participants received a small gift voucher after completing the questionnaire. Questionnaire completion required approximately 15–20 min. All questionnaire items were configured as required fields to minimise missing data. After submission, completed questionnaires were checked for completeness.

2.4 Measures

2.4.1 Demographic characteristics

Demographic information included age, sex, academic year group, birth order, major, religious affiliation, illness or physical discomfort, family economic status, receipt of government subsidies, and parental marital status. Academic year was grouped as Years 1–2, Years 3–4 and Years 5 or higher to account for differences in program length across health professions. Family economic status was self-reported using four predefined categories reflecting annual household income: well-off, average, lower-middle-income, and low-income.

2.4.2 Perceived stress scale

Perceived stress was assessed using the 10-item Perceived Stress Scale (PSS-10). The scale assesses the extent to which individuals perceive situations in their lives as unpredictable, uncontrollable, and stressful. Items are rated on a 5-point frequency scale ranging from 0 (never) to 4 (very often). Items 4, 5, 7, and 8 are reverse scored, and item scores are summed to obtain a total score ranging from 0 to 40, with higher scores indicating greater perceived stress (19). Previous studies have demonstrated satisfactory reliability and validity of the PSS-10 across different populations (20). In the present study, Cronbach's alpha for the PSS-10 was 0.82.

2.4.3 Emotion regulation questionnaire

Emotion regulation was assessed using the 10-item Emotion Regulation Questionnaire (ERQ). The ERQ was developed to assess individuals' tendencies to regulate their emotional responses and includes two emotion regulation strategies: cognitive reappraisal and expressive suppression. Items are rated on a 7-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). The original study reported Cronbach's alpha coefficients of 0.79 for cognitive reappraisal and 0.73 for expressive suppression, indicating acceptable internal consistency for both subscales (6). Subscale scores were calculated by summing the corresponding items, with higher scores indicating greater use of each emotion regulation strategy. In the present study, cognitive reappraisal and expressive suppression were analyzed as separate subscales. Cognitive reappraisal was assessed using six items, and expressive suppression was assessed using four items. Cronbach's alpha was 0.856 for cognitive reappraisal and 0.732 for expressive suppression.

2.4.4 Academic resilience scale

Academic resilience was assessed using the 30-item Academic Resilience Scale (ARS-30), which comprises three dimensions: perseverance, reflecting and adaptive help-seeking, and negative affect and emotional response (21). Items were rated on a 5-point Likert scale, with higher overall scores indicating greater academic resilience. The original ARS-30 demonstrated good internal consistency, with a Cronbach's alpha of 0.90 for the global scale (21). The overall academic resilience score was used because the original ARS-30 permits calculation of a global score and the present study focused on overall academic resilience rather than dimension-specific effects. In the present sample, Cronbach's alpha for the overall scale was 0.822.

2.5 Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 27.0, and the PROCESS macro, version 4.2. Descriptive statistics were used to summarize participant characteristics and study variables. Categorical variables are presented as frequencies and percentages, whereas continuous variables are presented as means and standard deviations. Pearson correlation coefficients were calculated to examine the bivariate associations among cognitive reappraisal, expressive suppression, academic resilience, and perceived stress. PROCESS Model 4 was conducted separately for cognitive reappraisal and expressive suppression to evaluate their statistical indirect associations with perceived stress through academic resilience (22). In each analysis, the ERQ subscale was specified as X, academic resilience as M, and perceived stress as Y. The a path represented the association between the ERQ subscale and academic resilience. The b path represented the association between academic resilience and perceived stress while controlling for the ERQ subscale. The c path represented the total association between the ERQ subscale and perceived stress, and the c′ path represented the direct association after academic resilience was included in the model. The statistical indirect association was evaluated using 5,000 bootstrap resamples and 95% percentile bootstrap confidence intervals. A statistical indirect association was considered significant when the bootstrap confidence interval did not include zero. Unstandardized regression coefficients (B), standard errors (SE), and 95% confidence intervals are reported where appropriate. For all other statistical tests, two-tailed p values <.05 were considered statistically significant. Sensitivity analyses were additionally conducted by entering demographic and contextual variables as covariates in the indirect-association models. These variables included age, sex, academic year group, birth order, major, religion, illness/discomfort, family economic status, receipt of government subsidies, and parental marital status. Each covariate was examined separately, and an additional model included the covariates simultaneously to assess whether the main findings were robust to demographic and contextual adjustment.

2.6 Ethical considerations

The study protocol was reviewed and approved by the Institutional Review Board of Tri-Service General Hospital (approval No. A202105027). Before participation, all eligible students received information regarding the study purpose, procedures, voluntary nature of participation, potential risks and benefits, and their right to withdraw from the study at any time without penalty. Written informed consent was obtained from all participants before questionnaire completion. Participant anonymity and confidentiality were maintained throughout data collection, analysis, and data management. All study procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki (23).

3 Results

3.1 Participant characteristics

A total of 180 health professions students were included in the analysis. The mean age of the participants was 21.99 years (SD = 1.47), and 119 (66.11%) were male. Most participants were in Years 3–4 of their programs ($n = 144$, 80.0%). Academic year was grouped to account for differences in program length across health professions. Medicine was the most common major ($n = 83$, 46.11%), followed by nursing ($n = 62$, 34.44%), public health ($n = 22$, 12.22%), pharmacy ($n = 7$, 3.89%), and dentistry ($n = 6$, 3.33%). Most participants reported no religious affiliation ($n = 117$, 65.00%) and no illness or physical discomfort ($n = 167$, 92.78%). Additional participant characteristics are presented in Table 1.

TABLE 1 Demographic characteristics of the study participants ($N = 180$).

Variable	Mean (SD)	n (%)
Age (years)	21.99 (1.47)	
Sex		
Male		119 (66.11)
Female		61 (33.89)
Academic year group		
Years 1–2		15 (8.33)
Years 3–4		144 (80.00)
Years 5 or higher		21 (11.67)
Birth order		
Eldest		72 (40.00)
Middle		21 (11.67)
Youngest		67 (37.22)
Only child		20 (11.11)
Major		
Medicine		83 (46.11)
Dentistry		6 (3.33)
Pharmacy		7 (3.89)
Nursing		62 (34.44)
Public Health		22 (12.22)
Religion		
Yes		63 (35.00)
No		117 (65.00)
Illnesses or Discomfort		
Yes		13 (7.22)
No		167 (92.78)
Family Economic Status		
Well-off		79 (43.89)
Average		97 (53.89)
Lower-middle-income		4 (2.22)
Low-income		0 (0.00)
Government Subsidies		
Yes		6 (3.33)
No		174 (96.67)
Parent Marital Status		
Married		163 (90.56)
Divorced		11 (6.11)
Separated		6 (3.33)

SD, standard deviation.

3.2 Associations among ERQ subscales, academic resilience, and perceived stress

Descriptive statistics and Pearson correlation coefficients for the study variables are presented in Table 2. Cognitive reappraisal was positively associated with academic resilience ($r = 0.56$, $p < .001$) and negatively associated with perceived stress ($r = -0.29$, $p < .001$). Expressive suppression was not significantly associated with academic resilience ($r = -0.06$, $p = .402$) or perceived stress ($r = 0.03$, $p = .649$). Academic resilience was negatively associated with perceived stress ($r = -0.38$, $p < .001$). The association between cognitive reappraisal and academic resilience was relatively strong, while the associations with perceived stress were small to moderate.

3.3 Indirect associations of ERQ subscales With perceived stress through academic resilience

PROCESS Model 4 was conducted separately for the two ERQ subscales to evaluate their statistical indirect associations with perceived stress through academic resilience. Regression coefficients for the component paths are presented in Table 3, whereas the total, direct, and statistical indirect associations are summarized in Table 4. For cognitive reappraisal, higher scores were positively associated with academic resilience ($B = 1.04$, $SE = 0.12$, $t = 9.01$, $p < .001$, 95% CI [0.81, 1.26]). This model explained approximately 31% of the variance in academic

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resilience ($R^2 = 0.31$, $F = 81.11$, $p < .001$). When cognitive reappraisal and academic resilience were entered simultaneously into the model predicting perceived stress, academic resilience was negatively associated with perceived stress (B = −0.15, SE = 0.04, $t = -3.88$, $p < .001$, 95% CI [−0.23, −0.07]). The direct association between cognitive reappraisal and perceived stress was not statistically significant (B = −0.09, SE = 0.07, $t = -1.26$, $p = .211$, 95% CI [−0.23, 0.05]). The total association between cognitive reappraisal and perceived stress was significant (effect = −0.25, SE = 0.06, $t = -3.98$, $p < .001$, 95% CI [−0.37, −0.13]). The statistical indirect association through academic resilience was significant (effect = −0.16, Boot SE = 0.04, 95% percentile bootstrap CI [−0.24, −0.07]).

For expressive suppression, there was no significant association with academic resilience (B = −0.14, SE = 0.16, $t = -0.84$, $p = .402$, 95% CI [−0.45, 0.18]). Academic resilience was negatively associated with perceived stress in this model (B = −0.18, SE = 0.03, $t = -5.48$, $p < .001$, 95% CI [−0.24, −0.11]). Expressive suppression was also not significantly associated with perceived stress after academic resilience was included in the model (B = 0.01, SE = 0.07, $t = 0.15$, $p = .884$, 95% CI [−0.13, 0.15]). The total association between expressive suppression and perceived stress was not significant (effect = 0.03, SE = 0.08, $t = 0.46$, $p = .649$, 95% CI [−0.11, 0.18]). The statistical indirect association through academic resilience was also not significant (effect = 0.02, Boot SE = 0.03, 95% percentile bootstrap CI [−0.04, 0.10]).

TABLE 2 Descriptive statistics and correlations among ERQ subscales, academic resilience, and perceived stress.

Variable	1	2	3	4	*M*	*SD*
1. Academic resilience	1				106.62	9.68
2. Cognitive reappraisal	0.56***	1			30.87	5.23
3. Expressive suppression	−0.06	−0.27***	1		13.91	4.51
4. Perceived stress	−0.38***	−0.29***	0.03	1	19.44	4.54

M, mean; SD, standard deviation.
***$p < .001$.

Sensitivity analyses were conducted by adjusting separately for age, sex, academic year group, major, birth order, religion, illness/discomfort, family economic status, receipt of government subsidies, and parental marital status. The overall pattern of findings remained unchanged across these adjusted models. For cognitive reappraisal, the statistical indirect association through academic resilience remained significant in all models, whereas the corresponding indirect association for expressive suppression remained non-significant. When these demographic and contextual covariates were entered simultaneously, the indirect association for cognitive reappraisal remained significant (effect = −0.161, 95% bootstrap CI [−0.257, −0.068]), whereas

TABLE 4 Total, direct, and statistical indirect associations of ERQ subscales with perceived stress through academic resilience.

ERQ subscale/ Association	Estimate	SE	*t*	*p*	95% CI
Cognitive reappraisal					
Total association	−0.25	0.06	−3.98	<.001	−0.37 to −0.13
Direct association	−0.09	0.07	−1.26	.211	−0.23 to 0.05
Statistical indirect association through academic resilience	−0.16	0.04	—	—	−0.24 to −0.07
Expressive suppression					
Total association	0.03	0.08	0.46	.649	−0.11 to 0.18
Direct association	0.01	0.07	0.15	.884	−0.13 to 0.15
Statistical indirect association through academic resilience	0.02	0.03	—	—	−0.04 to 0.10

Academic resilience was specified as M and perceived stress as Y. Separate PROCESS Model 4 analyses were conducted for cognitive reappraisal and expressive suppression. Statistical indirect associations were estimated using 5,000 bootstrap resamples and are presented with 95% percentile bootstrap confidence intervals. Because the data were cross-sectional, the indirect associations should not be interpreted as evidence of causal mediation.
SE, standard error; CI, confidence interval.

TABLE 3 PROCESS model 4 regression results for the associations of ERQ subscales with perceived stress through academic resilience.

Model/Predictor	Outcome	B	SE	*t*	*p*	95% CI
Cognitive reappraisal model						
Cognitive reappraisal	Academic resilience	1.04	0.12	9.01	<.001	0.81 to 1.26
Cognitive reappraisal	Perceived stress	−0.09	0.07	−1.26	.211	−0.23 to 0.05
Academic resilience	Perceived stress	−0.15	0.04	−3.88	<.001	−0.23 to −0.07
Expressive suppression model						
Expressive suppression	Academic resilience	−0.14	0.16	−0.84	.402	−0.45 to 0.18
Expressive suppression	Perceived stress	0.01	0.07	0.15	.884	−0.13 to 0.15
Academic resilience	Perceived stress	−0.18	0.03	−5.48	<.001	−0.24 to −0.11

Academic resilience was specified as M and perceived stress as Y. Separate PROCESS Model 4 analyses were conducted for cognitive reappraisal and expressive suppression. Statistical indirect associations were estimated using 5,000 bootstrap resamples and are presented with 95% percentile bootstrap confidence intervals.
SE, standard error; CI, confidence interval.

the indirect association for expressive suppression remained non-significant (effect = 0.028, 95% bootstrap CI [−0.033, 0.103]).

4 Discussion

The present study examined how cognitive reappraisal and expressive suppression were associated with academic resilience and perceived stress among health professions students. Cognitive reappraisal showed a different pattern from expressive suppression, particularly in its association with academic resilience and perceived stress. The positive association between cognitive reappraisal and academic resilience was consistent with previous research showing that greater use of cognitive reappraisal was associated with higher academic resilience among university students (24, 25).

Previous research has also reported a positive relationship between emotion regulation ability and resilience, supporting the conceptual link between these psychological resources (26). Health professions students encounter multiple academic and clinical demands that require them to manage emotional responses while maintaining concentration, persistence, and engagement. Recent research has similarly emphasized the relevance of emotion regulation to student mental health and adjustment. Among nursing students, emotion regulation has been examined in direct relation to perceived stress (27). Emotion regulation strategies were associated with depression and stress among undergraduate students (10). Adaptive emotion regulation has also been associated with lower burnout among medical students (11). Other studies have also reported associations between cognitive emotion regulation strategies, academic stress, health behaviors, and health-related outcomes among university students (12).

Academic resilience may be particularly relevant in health professions education because students are exposed to sustained academic requirements and progressive clinical responsibilities. Previous cross-national research has shown a negative association between perceived stress and academic resilience among university students (17), and resilience-related resources have also been examined in relation to academic stress and test anxiety among medical students (18). These findings suggest that resilience may be relevant to how students adapt psychologically to demanding educational environments. Previous research among medical students has shown that resilience may be involved in the association between stress-related factors and academic burnout (28). Adaptive emotion regulation has also been linked with lower burnout, while psychological resilience has been examined in relation to test anxiety and other academic stressors (11, 18). Because all variables were measured at the same time, perceived stress may also be related to how students regulate emotions or respond to academic difficulties. In addition, other unmeasured factors may partly explain the observed associations.

Previous studies have often examined emotion regulation, resilience, and perceived stress separately. This study examined these factors within the same model in students from several health professions in Taiwan. The unique findings suggest that different emotion regulation strategies may show different patterns of association with academic adaptation and perceived stress. Cognitive reappraisal was positively associated with academic resilience and showed a significant total, but not direct, association with perceived stress, whereas expressive suppression was not significantly associated with either academic resilience or perceived stress. The nonsignificant findings for expressive suppression may indicate that its relationship with academic adaptation and perceived stress is less consistent than that of cognitive reappraisal. Recent cross-cultural evidence suggests that the psychological correlates of expressive suppression may vary across cultural contexts (29). The effects of suppression may also differ according to emotional valence. Research involving participants from Taiwan and the United States found that suppression of positive emotions, but not negative emotions, consistently predicted lower well-being (30). Thus, the absence of significant associations in the present study should not be interpreted as evidence that expressive suppression is irrelevant, but rather that its relationship with academic resilience and perceived stress may be more context-dependent in this sample. This suggests that emotion regulation may be better understood in a strategy-specific way rather than as a single psychological resource. The findings also highlight academic resilience as a context-specific resource that may be particularly relevant to how health professions students adapt to academic demands.

4.1 Limitations

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional design precludes conclusions regarding temporal ordering or causality among cognitive reappraisal, expressive suppression, academic resilience, and perceived stress. Although the PROCESS analysis identified a significant statistical indirect association between cognitive reappraisal and perceived stress through academic resilience, the data were collected at a single time point and cannot establish temporal or causal relationships. Second, participants were recruited through convenience sampling from a single medical university in northern Taiwan. Although students from several health professions and different academic years were included, most participants were in their third or fourth year. Therefore, the findings may be less generalizable to students in earlier or later stages of training, as well as to students from other universities or countries. Third, the eligibility criteria excluded students with selected psychiatric, cognitive, sleep-related, physical health, substance-use, or medication-related conditions that could influence perceived stress or emotional responses. These exclusions may have resulted in a relatively healthier sample and may limit the generalizability of the findings to students with greater psychological distress or more complex health needs.

Fourth, all study variables were assessed using self-report questionnaires administered at the same time. The findings may therefore have been influenced by recall bias, social desirability, and the use of self-report measures for all study variables. Because all main variables were assessed using self-report measures at the same time, common-method bias cannot be ruled out. Fifth, although the present study focused primarily on the overall academic resilience score, supplementary analyses also examined the three ARS-30 dimensions. These dimension-

specific findings should be interpreted cautiously because the study was not originally designed to compare the individual dimensions. Finally, the present study examined statistical associations among the study variables rather than the effectiveness of specific interventions.

4.2 Implications for health psychology and health professions education

The present findings highlight cognitive reappraisal and academic resilience as potentially relevant psychological resources in understanding perceived stress among health professions students. From a health psychology perspective, the findings suggest that students' responses to demanding academic and clinical environments may be associated not only with the stressors they encounter but also with psychological resources related to emotional self-regulation and adaptation to academic adversity. Within health professions education, these findings may help identify areas for future student support, including cognitive reappraisal, academic resilience, and stress management. Potential areas for future study could include psychoeducational programs, skills-based workshops, reflective learning activities, peer-support approaches, or structured student well-being services. However, because the present study was cross-sectional and did not evaluate an intervention, these applications should be considered potential directions rather than evidence-based recommendations for effectiveness. Integrating psychological well-being into health professions education may also be particularly relevant because these students are preparing for occupations that involve sustained academic, interpersonal, and clinical demands.

4.3 Recommendations for future research

Future longitudinal studies should examine whether cognitive reappraisal predicts later academic resilience and whether academic resilience predicts later perceived stress. Studies with repeated assessments are also needed to clarify the direction and stability of these associations. Studies across different academic years and levels of clinical exposure could further examine whether these associations differ across stages of training. Research involving students from multiple universities, health professions, and geographical regions is also needed to examine the generalizability of the present findings. Future studies should examine whether the observed relationships are replicated in more heterogeneous student populations, including students with a wider range of health and developmental characteristics. More diverse samples could help determine whether the observed associations differ across professional disciplines, academic years, and levels of clinical exposure. Future studies may also examine additional psychological and contextual factors that could influence these relationships, including social support, coping strategies, academic stressors, burnout, psychological flexibility, and learning-environment characteristics. Such studies may help clarify how psychological resources and educational demands are related to student well-being. Future research could also consider combining self-report measures with physiological indicators, such as salivary cortisol, as well as structured behavioral observations, to provide a more comprehensive assessment of emotion regulation, academic resilience, and perceived stress. Finally, intervention studies are needed to examine whether approaches targeting cognitive reappraisal skills and academic resilience are associated with changes in perceived stress and psychological well-being. Randomized or prospective intervention designs would provide stronger evidence regarding the potential effectiveness of such strategies in health professions education.

5 Conclusion

This study examined cognitive reappraisal, expressive suppression, academic resilience, and perceived stress within the same model among students from various health professions in Taiwan. Cognitive reappraisal and expressive suppression showed different patterns of association with academic resilience and perceived stress. These findings add to current evidence by suggesting that different emotion regulation strategies may show distinct patterns of association with stress and academic adaptation in health professions students. Academic resilience may also be particularly relevant as a context-specific resource in this setting. Because the study was cross-sectional, the findings do not establish temporal or causal relationships. Longitudinal and intervention studies are needed to examine these relationships over time and to test whether changes in cognitive reappraisal or academic resilience are followed by changes in perceived stress.

Data availability statement

The datasets generated and analyzed during the current study are not publicly available to protect participant privacy and confidentiality, but are available from the corresponding author upon reasonable request.

Ethics statement

The study involving human participants was approved by the Institutional Review Board (IRB) of Tri-Service General Hospital (approval No. A202105027) and conducted in accordance with the Declaration of Helsinki and applicable institutional guidelines. Written informed consent was obtained from all participants before participation.

Author contributions

YC: Writing – original draft, Investigation, Data curation, Methodology, Conceptualization, Formal analysis. YT: Methodology, Conceptualization, Investigation, Writing – review & editing. YH: Methodology, Investigation, Conceptualization, Writing – review & editing. HW: Writing – review & editing, Investigation, Conceptualization, Formal analysis. HL: Writing – review & editing, Methodology, Investigation, Formal analysis. JL: Conceptualization, Investigation, Funding acquisition, Resources, Writing – review & editing, Methodology, Data curation.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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