COVID stress and depressive symptoms among high school students: a moderated mediation model of sleep quality and optimism

Hung Thanh Nguyen, Thi Truc Quynh Ho and Long Dau Minh
University of Education, Hue University, Hue City, Vietnam

Abstract

Purpose – This study aimed to investigate whether optimism buffers an indirect relationship between COVID stress and depressive symptoms via poor sleep quality among Vietnamese high school students.

Design/methodology/approach – Six hundred and eighty-five participants completed the Coronavirus Stress Measure, the Life Orientation Test-Revised, the Pittsburgh Sleep Quality Index and the Depression, Anxiety and Stress Scales. Process Macro 3.5 for SPSS (Model 4 and Model 14) was used to analyze the mediating effect and moderated mediation effect.

Findings – The results indicated that COVID stress was associated with an increase in depressive symptoms via the indirect pathway of poor sleep quality. Furthermore, optimism moderated the indirect relationship between COVID stress and depressive symptoms through poor sleep quality among Vietnamese students.

Originality/value – The study's findings may serve as a basis for the development of depression prevention interventions for students with high COVID stress in the COVID-19 pandemic.

Keywords COVID stress, Depressive symptoms, Optimism, Sleep quality, Moderated mediation model

Paper type Research paper

Introduction

The coronavirus disease 2019 (also known as COVID-19) first appeared in December 2019 in China (Rothan and Byrareddy, 2020), then spread to many countries around the world. So far, it has been negatively affecting the physical and psychological health of each individual (Liu and Wang, 2021). According to First *et al.* (2021), exposure to COVID-19 (including experiences such as COVID-19 infection, hospitalization for COVID-19, or the death of a loved one from COVID-19) may be associated with adverse mental health. During the pandemic, the proportions of the population experiencing stress, anxiety and depression were 29.6%, 31.9% and 33.7%, respectively (Salari *et al.*, 2020). Among them, an estimated 25.2%–52.4% of adolescents suffered from depression during the pandemic (Zhang *et al.*, 2020; Racine *et al.*, 2021). In Vietnam, the fourth wave of the COVID-19 epidemic started on April 27, 2020, and has not ended yet. An estimated 23.5%, 14.1% and 22.3% of the Vietnamese population suffer from depression, anxiety and stress, respectively, due to the COVID-19 pandemic (Ngoc Cong Duong *et al.*, 2020). Among them, the prevalence of depression among adolescents and young adults was 9% (Porter *et al.*, 2021). Although the prevalence of depression among adolescents varies from country to country, the spread of COVID-19 and social distancing can increase mental distress, such as stress, anxiety and depressive symptoms (Hawes *et al.*, 2021; Lakhan *et al.*, 2020).

In the literature, COVID stress was found to be associated with depressive symptoms among college students (Arslan and Yıldırım, 2021; Liu and Wang, 2021) and sleep quality, meaning in life, optimism and pessimism were factors mediating the association between COVID stress and depressive symptoms among college students and adults (Arslan and Yıldırım, 2021; Coiro et al., 2021). Due to the COVID-19 epidemic, adolescents' physical and mental health are also significantly affected (Wright et al., 2021). Because of COVID-19, adolescents are excluded from school, have to get used to new forms of learning (online learning), reduce physical interactions with others, overuse the Internet and social media, etc. and do other things that are detrimental to their mental health. However, research on the association between COVID stress and depressive symptoms, as well as the role of sleep quality and optimism in adolescents, still has many gaps. This study aims to evaluate the association between COVID stress and depressive symptoms among high school students in Vietnam. At the same time, this study also aims to evaluate the role of sleep quality and optimism in the association between COVID stress and depressive symptoms.

Literature

The association between COVID stress and depressive symptoms

Previous studies indicated that COVID stress may increase depressive symptoms in adolescents (Arslan and Yıldırım, 2021; Liu and Wang, 2021). In this study, COVID stress was defined as an individual's feelings or thoughts about the level of stress they are experiencing in the COVID-19 pandemic. Depression is a mood disorder with symptoms such as sadness, loss of interest, loss of concentration, feelings of low self-worth and guilt and sleep and eating disorders (Wilhelm Kirch, 2008). Individuals with higher levels of COVID stress tended to report more depressive symptoms (Liu and Wang, 2021; Arslan and Yıldırım, 2021). Yan et al. (2021) reported that individuals with higher levels of perceived stress may have negative perceptions and negative emotions and are at risk of experiencing poor mental health. According to Arslan and Yıldırım (2021), COVID stress can cause individuals to lose meaning and purpose in life, reduce optimism, or increase pessimism, which can increase depressive symptoms. Thus, the association between COVID stress and depressive symptoms has been confirmed in previous studies. However, there is a lack of studies focusing on mediators and buffers in the association between COVID stress and depressive symptoms in adolescents, especially among Vietnamese students.

The mediating effect of sleep quality on the association between COVID stress and depressive symptoms

Previous research has shown that in the COVID-19 pandemic, perceived stress is positively correlated with general sleep status (Wu et al., 2021), poor sleep quality (SQ) and insomnia (Barutcu Atas et al., 2021). In the COVID-19 pandemic, stress can change sleep quality, including sleep latency, being awake during the night and sleep duration (Siddique et al., 2021). Therefore, stress is a risk factor for poor SQ in the COVID-19 pandemic. Stress is also an important factor in the onset and progression of sleep disorders (Siddique et al., 2021). On the other hand, dissatisfaction with sleep quality can cause psychological health problems (João et al., 2018). Poor SQ increases symptoms of anxiety and depression in the COVID-19 pandemic (Coiro et al., 2021). Previous research has revealed that sleep plays an important role in promoting an individual's resilience when they face stress or adversity (Besedovsky et al., 2019). Individuals with poor SQ often report lower psychological resilience or high anxiety than those with good sleep quality (Palagini et al., 2018; Richardson et al., 2019; Coiro et al., 2021), while psychological resilience or high anxiety can reduce the risk of experiencing depressive symptoms in the COVID-19 pandemic (Karasar and Canlı, 2020; Havnen et al.,

2020). Recently, Coiro *et al.* (2021) found that poor SQ mediates the link between COVID-related stressors and depression. Therefore, in this study, we expect that poor SQ will mediate the link between COVID stress and depressive symptoms.

The moderating effect of optimism on the indirect association between COVID stress and depressive symptoms

Optimism refers to an individual's hope that something good will happen in the future (Coelho *et al.*, 2018). Conversely, pessimism refers to an individual's lack of hope and belief in the future. Optimism and pessimism have a powerful impact on an individual's mental health (Arslan and Yıldırım, 2021; Chen *et al.*, 2021). Pessimism can increase depressive symptoms, while optimism can reduce individuals' depressive symptoms (Anzaldi and Shifren, 2019). Previous research has shown that, in the COVID-19 pandemic, optimism may be able to reduce the positive effects of COVID stress on depressive symptoms; however, pessimism can increase the positive effects of COVID stress on depressive symptoms (Arslan and Yıldırım, 2021). In the COVID-19 pandemic, optimism can be seen as a protective factor for individuals with mental health problems (Vos *et al.*, 2021). Optimism can increase self-esteem, social support, subjective well-being and hope, while pessimism can increase symptoms of stress, anxiety and depression in individuals (Arslan and Yıldırım, 2021). On the other hand, previous evidence has shown that individuals with poorer sleep quality reported more depressive symptoms in the COVID-19 pandemic (Coiro *et al.*, 2021). Therefore, previous studies have demonstrated associations between optimism and depressive symptoms as well as between poor SQ and depressive symptoms in the COVID-19 pandemic. From previous findings, we believe that individuals with low levels of optimism and poor SQ tend to report more depressive symptoms than individuals with high levels of optimism and good sleep quality. In other words, we would expect that optimism might moderate the link between poor SQ and depressive symptoms.

Research hypothesis

Based on previous research results, this study aims to test the following three hypotheses: COVID stress would be positively related to depressive symptoms (Hypothesis 1); poor SQ would mediate the link between COVID stress and depressive symptoms (Hypothesis 2); and optimism would buffer the indirect relation between COVID stress and depressive symptoms (Hypothesis 3) (see Figure 1).

Methods

Sample

The data was collected in October 2021 through an online survey. First, the researchers asked for approval from the principals of the high schools and the students' parents. All parents signed consent forms for their children to participate in the study. Then we had an online
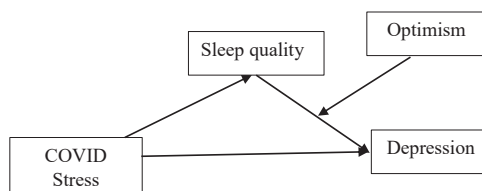
Source(s): Author's own creation

meeting with the form teachers to ask for their help. Finally, the participants received the survey link from their form teachers via social networks (Facebook or Zalo). Before answering the questionnaire, the participants were asked to sign a consent form to participate in the study. If involuntary, students may not participate in the survey without evaluation or criticism.

A total of 685 high school students in Vietnam (67.4% of the participants were female students) completed our survey. The questionnaire was designed to collect information including age, gender, grade, COVID stress, sleep quality, optimism and depression. The mean age of the participants was 16.09 (SD = 0.860, range = 15–19 years) (see Table 1).

Measures
COVID stress: To measure COVID-related stress, we adapted the Coronavirus Stress Measure (CSM, Arslan *et al.*, 2021), which consists of five items (e.g. "How often have you been upset because of the COVID-19 pandemic?"). Each item is rated on a five-point scale (0 = never, 4 = very often). Lower scores indicate a lower level of stress related to COVID-19. Our adaptive results have shown that the Vietnamese version of CSM has good reliability (α = 0.820; Retest: α = 0.767) and validity (X^2/df = 1.576 ($\leq$3), *CFI* = 0.986 (>0.90), *GFI* = 0.975 (>0.90), NFI = 0.965 (>0.90), TLI = 0.966 (>0.90), *RMSEA* = 0.078 ($\leq$0.08). In this study, Cronbach's alpha for the CSM was 0.853.

Depressive symptoms: To measure depressive symptoms, we used the depression subscale of the Depression, Anxiety and Stress Scales (DASS 21, Lovibond and Lovibond, 1995). It contains seven items measuring depressive symptoms (e.g. "I couldn't seem to experience any positive feelings at all"). Each item is rated on a 4-point Likert scale ranging from 0 (never) to 3 (always). The sum of the 7 items multiplied by 2 represents the total score, with a lower score representing a lower level of depression. DASS 21 is a scale of stress, anxiety and depression commonly used in Vietnam. In this study, Cronbach's alpha for the depression subscale was 0.889.

Optimism: To measure optimism, we used the ten-item Life Orientation Test-Revised (LOT-R, Scheier and Carver, 1985). Sample items included "it's easy for me to relax". A range of scores from 0 (strong disagree) to 4 (strong agree) is given for each item. Out of 10 items, 4 are not scored and 3 are reverse scored. Totals ranging from 0 to 24, with a higher score indicating greater optimism. The LOT-R has been used in the Vietnamese sample and shows good reliability and validity (Tường and Long, 2016). In this study, the internal consistency of LOT-R was good (α = 0.817).

Sleep quality: To measure sleep quality, we used the Pittsburgh Sleep Quality Index (PSQI, Buysse *et al.*, 1989). This is an 18-question (both open and closed) scale that measures the seven components of sleep quality. Sample items included "wake up in the middle of the night

	n	%
Gender		
Male	233	32.6
Female	462	67.4
Age, M ± SD	16.09 ± 0.860	
Grade		
10th grade	254	37.1
11th grade	219	32.0
12th grade	212	30.9

Table 1.
Demographic of respondents (n = 685) **Source(s):** Author's own creation

or early morning". All closed questions are rated using a four-point Likert-type scale, ranging from 0 (very good/not during the past month) to 3 (very bad/three or more times a week). The sum of the seven components represents the global sleep quality scores, with a lower score representing a better level of sleep quality. Previous research indicated that the PSQI provided good internal reliability estimates (To and Nguyen, 2015). In this study, Cronbach's alpha for the PSQI was 0.751.

Data analysis
In this study, we used SPSS 20.0 and Process Macro 3.5 to analyze the data. Before analyzing the moderated mediation effect, we conducted descriptive statistics and correlation analyses between variables. After preliminary analysis, we use PROCESS Macro 3.5 (A. F. Hayes, 2018) for SPSS (Model 4 and Model 14) to analyze the mediating effect and moderated mediation effect. Mediation analysis (Model 4) was used to determine whether sleep quality mediates the association between COVID stress and depressive symptoms. The mediating effect of sleep quality was significant when the confidence interval (CI) for the indirect effect of COVID stress on depression through sleep quality did not contain 0. Moderated mediation analysis (Model 14) was used to determine whether optimism moderated the indirect relationship between COVID stress and depressive symptoms. The moderated mediation effect is significant when three conditions are met: (1) the CI of the indirect effect from COVID stress to depression through sleep quality does not contain 0; (2) the CI of the interaction between SQ and optimism does not contain 0; and (3) the CI of the index of moderated mediation does not contain 0.

Results
Correlation analysis
Table 2 showed the means (SD) and correlations among the variables studied. According to Table 2, COVID stress was positively correlated with poor SQ ($r = 0.178, p < 0.01$) and depressive symptoms ($r = 0.190, p < 0.01$). Poor SQ was negatively correlated with optimism ($r = -0.096, p < 0.05$) and positively correlated with depressive symptoms ($r = 0.424, p < 0.01$). Optimism was negatively correlated with depressive symptoms ($r = -0.299, p < 0.01$).

Analyze the mediating role of sleep quality in the relationship between COVID stress and depressive symptoms
Mediation model analysis (Table 3) showed that COVID stress can positively predict poor SQ (B = 0.123, SE = 0.026, 95% CI = [0.073, 0.173]) and depressive symptoms (B = 0.241, SE = 0.071, 95% CI = [0.102, 0.381]); poor SQ can positively predict depressive symptoms (B = 1.194, SE = 0.105, 95% CI = [0.989, 1.400]). The indirect effect of COVID stress on depressive symptoms through poor SQ was significant (B = 0.147, SE = 0.043, 95% CI = [0.070, 0.238]). Therefore, poor SQ partially mediated the link between COVID stress and depressive symptoms among high school students (see Figure 2).

	Mean	SD	COVID stress	Poor SQ	Optimism
COVID stress	8.46	4.224			
Poor SQ	6.41	2.887	0.178**		
Optimism	14.867	3.265	−0.025	−0.096*	
Depression	9.51	8.574	0.190**	0.424**	−0.299**

Note(s): *: $p < 0.05$; **: $p < 0.01$; SQ: sleep quality
Source(s): Author's own creation

Table 2.
Pearson correlations, mean and standard deviations among study variables

Analyze the moderating role of optimism in the indirect relationship between COVID stress and depression symptoms

Table 4 indicated that COVID stress and poor SQ positively predicted depressive symptoms (B = 0.247, SE = 0.068, 95% CI = [0.114, 0.381] and B = 2.175, SE = 0.393, 95% CI = [1.404, 2.945], respectively). COVID stress positively predicted poor SQ (B = 0.123, SE = 0.026, 95% CI = [0.073, 0.173]).

The interaction between poor SQ and optimism was significant (B = −0.074, SE = 0.027, 95% CI = [-0.126, −0.021]), indicating optimism moderated the effects of poor SQ on depressive symptoms. The simple slopes indicated that the association between poor SQ and depressive symptoms was much stronger among students with a low level of optimism (B = 1.320; SE = 0.122; 95% CI = [1.080, 1.560]); meanwhile, this association was weaker with a high level of optimism (B = 0.839; SE = 0.145; 95% CI = [0.555, 1.123]) (see Figure 3).

The results of the conditional indirect effects exploration indicated that the indirect effect was stronger among students with a low level of optimism (B = 1.162; SE = 0.046; 95% CI = [0.078, 0.259]); meanwhile, the indirect effect was weaker among students with a high level of optimism (B = 1.103; SE = 0.032; 95% CI = [0.048, 0.169]). The index of moderated mediation was significant (B = −0.009, SE = 0.005, 95% CI = [−0.018, −0.001]), suggesting that optimism moderated the indirect effect of COVID stress on depressive symptoms (see Figure 4).

Discussion

This study investigated the direct and indirect associations of COVID stress, sleep quality and optimism on depressive symptoms among Vietnamese high school students. After testing the hypotheses, we have the following key findings:

First, we found that COVID stress was directly associated with an increase in depressive symptoms among Vietnamese students. This result is consistent with previous findings that have shown that individuals with high stress levels due to COVID-19 tend to have increased

	B	SE	95% CI
Direct effect			
COVID stress ➲ PSQ	0.123***	0.026	[0.073, 0.173]
PSQ ➲ Depression	1.194***	0.105	[0.989, 1.400]
COVID stress ➲ Depression	0.241***	0.071	[0.102, 0.381]
Age ➲ PSQ	0.332**	0.126	[0.086, 0.579]
Age ➲ Depression	0.147	0.345	[−0.530, 0.825]
Indirect effect			
COVID stress ➲ PSQ ➲ Depression	0.147	0.043	[0.070, 0.238]

Table 3.
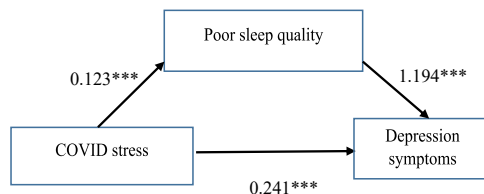The direct and indirect effects of COVID stress on depression symptoms

Note(s): **: *p* < 0.01, ***: *p* < 0.001, CI: Confidence interval, PSQ: Poor sleep quality
Source(s): Author's own creation

Figure 2.
Poor SQ as a mediator in the link between COVID stress and depression symptoms

Source(s): Author's own creation

Paths	B	SE	95%CI	
			Low	High
COVID stress ➲ Poor SQ	0.123***	0.026	0.073	0.173
COVID stress ➲ Depression	0.247***	0.068	0.114	0.381
Poor SQ ➲ Depression	2.175***	0.393	1.404	2.945
Optimism ➲ Depression	−0.181	0.201	−0.576	0.214
Poor SQ * Optimism	−0.074**	0.027	−0.126	−0.021
Age – Poor SQ	0.332**	0.126	0.086	0.579
Age-Depression	−0.066	0.330	−0.715	0.583
Conditional effects of the focal predictor at values of the moderator				
−1 SD below mean Optimism	1.320***	0.122	1.080	1.560
+1 SD below mean Optimism	0.839***	0.145	0.555	1.123
Conditional indirect effect at different values of Optimism				
−1 SD below mean Optimism	1.162	0.046	0.078	0.259
+1 SD below mean Optimism	1.103	0.032	0.048	0.169
Index of moderated mediation				
	−0.009	0.005	−0.018	−0.001

Note(s): **$p < 0.01$, ***$p < 0.001$, CI: Confidence interval, CVS: Coronavirus stress, SQ: sleep quality
Source(s): Author's own creation

**Table 4.**
Moderated mediation analysis
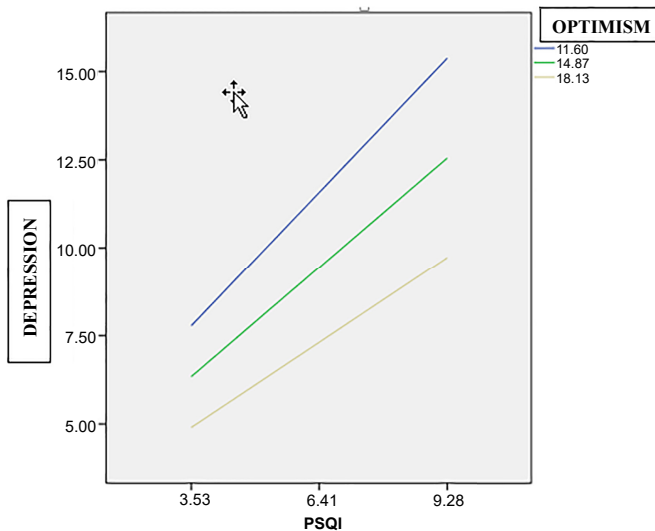
Source(s): Author's own work

Figure 3.
Optimism as a moderator in the link between poor SQ and depressive symptoms

depressive symptoms (First *et al.*, 2021; Liu and Wang, 2021; Arslan and Yıldırım, 2021). Like previous studies, we believe that COVID stress is associated with reduced meaning in life, decreased optimism, increased negative emotional experiences and impaired mental health (Arslan and Yıldırım, 2021; Yan *et al.*, 2021).

Second, consistent with previous findings (Coiro *et al.*, 2021), we found that COVID stress was associated with an increase in depressive symptoms via the indirect pathway of poor SQ. Previous studies indicated that COVID stress was related to poor SQ (Barutcu Atas *et al.*, 2021;
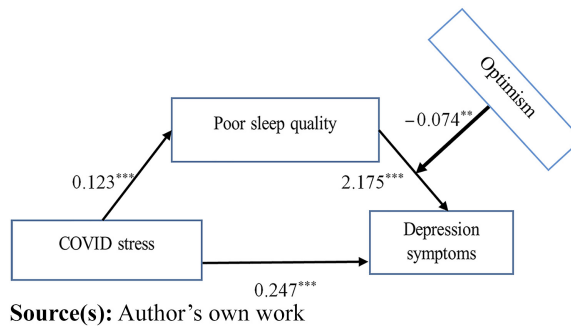
Figure 4.
The final moderated
mediation model

Source(s): Author's own work

Siddique *et al.*, 2021) and poor SQ was related to depressive symptoms (João *et al.*, 2018; Coiro *et al.*, 2021). In line with previous findings, we found that COVID stress reduces sleep quality and poor SQ increases depressive symptoms among students during the COVID-19 pandemic. Based on previous evidence, we assume that COVID stress has negative effects on sleep quality (sleep latency, sleep disturbances, sleep duration and insomnia) (Barutcu Atas *et al.*, 2021; Siddique *et al.*, 2021; Wu *et al.*, 2021). Then, individuals with poor SQ may experience reduced psychological resilience (Palagini *et al.*, 2018; Besedovsky *et al.*, 2019), thereby increasing their risk of depressive symptoms in the COVID-19 pandemic (Karasar and Canlı, 2020). These findings suggest that in the COVID-19 pandemic, sleep quality plays an important role in the path from COVID stress to depressive symptoms among Vietnamese students. Improving sleep quality may be helpful in reducing depressive symptoms for students with high levels of COVID stress.

Third, we found that optimism moderated the indirect relationship between COVID stress and depressive symptoms through poor SQ among Vietnamese students. The association between poor SQ and depressive symptoms was much stronger among students with a low level of optimism; meanwhile, this relationship was weaker with a high level of optimism. In explaining our results, it is possible that in the COVID-19 pandemic, optimism can help individuals protect their self-esteem, increase social support, increase subjective well-being and increase hope and even reduce symptoms of stress, anxiety and depression (Vos *et al.*, 2021; Arslan and Yıldırım, 2021). In addition, due to the impact of the Covid-19 pandemic, individuals with poor SQ tend to report low resilience (Palagini *et al.*, 2018; Besedovsky *et al.*, 2019) or high anxiety (Coiro *et al.*, 2021). Once resilience is impaired or anxiety levels are high, the individual's risk of depression increases (Karasar and Canlı, 2020; Havnen *et al.*, 2020). Consistent with previous findings, we found that optimism was negatively associated with depressive symptoms (Vos *et al.*, 2021; Arslan and Yıldırım, 2021) and poor SQ was positively associated with depressive symptoms (Coiro *et al.*, 2021). The above analyzes have implied that good sleep quality and high optimism are two factors that protect students from the risk of depression in the COVID-19 pandemic. Therefore, in the COVID-19 pandemic, students with poor SQ and low optimism had more depressive symptoms than other individuals. The finding that optimism moderates the indirect relationship between COVID stress and depressive symptoms through poor SQ is the new finding of this study.

By finding a direct and indirect link between COVID stress and depression in high school students in Vietnam, this study has had positive implications. On the theoretical side, the study complements the theory of the direct and indirect relationship between stress and depression in adolescents. Previously, COVID stress was found to be positively associated with depression among adults (Arslan and Yıldırım, 2021; Liu and Wang, 2021); sleep quality mediates the association between COVID stress and depression among U.S. and Israeli adults (Coiro *et al.*, 2021); and character strength moderated the association between perceived stress of COVID-19 and depression among adolescents in China (Liu and Wang, 2021). Our study is the first in Vietnam to

investigate the link between COVID stress and depressive symptoms as well as the role of sleep quality and optimism in a sample of adolescents. On the practical side, the results of this study indicate that: (1) students who are stressed by COVID are at increased risk of depression; (2) students whose sleep quality is poor due to COVID stress may be at increased risk of depression; and (3) students whose sleep quality was poor due to COVID stress had a higher risk of depression when having low levels of optimism. These results implied that both COVID stress, poor sleep quality and optimism contributed to the development of depression among students during the epidemic. Therefore, measures to reduce stress levels due to COVID, improve sleep quality and improve optimism levels among students can be useful in preventing and reducing depression.

This study has the full limitations of a cross-sectional study. A longitudinal study design may be essential to determining the direction of the relationship between COVID stress, sleep quality, optimism and depression. On the other hand, this study was conducted with a sample of Vietnamese students. The conclusions of this study may require caution when applied to other populations in Vietnam. Studies are needed on mediating and buffering the association between COVID stress and depressive symptoms in other populations (hospital workers, teachers, businesspeople, etc.). In addition, a mediated moderation model was examined in this study using the Hayes PROCESS macro in SPSS. The PROCESS will be far simpler to use for the majority of researchers than any structural equation modeling (SEM) program; however, the estimates of the direct and indirect effects, whether conditional or unconditional, are likely somewhat biased (Hayes *et al.*, 2017). Therefore, SEM analysis may be necessary because the effect of measurement error can be controlled.

Conclusion
The results of our study have demonstrated that the relationship between COVID stress and depressive symptoms in high school students in Vietnam is partially mediated by sleep quality. Furthermore, this indirect relationship was mediated by optimism. These findings confirm that it may be advantageous to reduce the risk of depression for high school students by reducing COVID stress levels, improving sleep quality and enhancing optimism among students.

References
Anzaldi, K. and Shifren, K. (2019), "Optimism, pessimism, coping, and depression: a study on individuals with Parkinson's disease", *The International Journal of Aging and Human Development*, Vol. 88 No. 3, pp. 231-249, doi: 10.1177/0091415018763401.

Arslan, G. and Yıldırım, M. (2021), "Coronavirus stress, meaningful living, optimism, and depressive symptoms: a study of moderated mediation model", *Australian Journal of Psychology*, Vol. 73 No. 2, pp. 113-124, doi: 10.1080/00049530.2021.1882273.

Arslan, G., Yıldırım, M., Tanhan, A., Buluş, M. and Allen, K.-A. (2021), "Coronavirus stress, optimism-pessimism, psychological inflexibility, and psychological health: psychometric properties of the coronavirus stress measure", *International Journal of Mental Health and Addiction*, Vol. 19 No. 6, pp. 2423-2439, doi: 10.1007/s11469-020-00337-6.

Barutcu Atas, D., Aydin Sunbul, E., Velioglu, A. and Tuglular, S. (2021), "The association between perceived stress with sleep quality, insomnia, anxiety and depression in kidney transplant recipients during Covid-19 pandemic", *PLOS ONE*, Vol. 16 No. 3, pp. 1-12, doi: 10.1371/journal.pone.0248117.

Besedovsky, L., Lange, T. and Haack, M. (2019), "The sleep-immune crosstalk in health and disease", *Physiological Reviews*, Vol. 99 No. 3, pp. 1325-1380, doi: 10.1152/physrev.00010.2018.

Buysse, D.J., Reynolds, C.F., Monk, T.H., Berman, S.R. and Kupfer, D.J. (1989), "The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research", *Psychiatry Research*, Vol. 28 No. 2, pp. 193-213.

Chen, Y., Su, J., Zhang, Y. and Yan, W. (2021), "Optimism, social identity, mental health: findings form Tibetan college students in China", *Frontiers in Psychology*, Vol. 12, pp. 1-10, doi: 10.3389/fpsyg. 2021.747515.

Coelho, G.L.H., Vilar, R., Hanel, P.H.P., Monteiro, R.P., Ribeiro, M.G.C. and Gouveia, V.V. (2018), "Optimism scale: evidence of psychometric validity in two countries and correlations with personality", *Personality and Individual Differences*, Vol. 134, pp. 245-251, doi: 10.1016/j.paid.2018.06.030.

Coiro, M.J., Asraf, K., Tzischinsky, O., Hadar-Shoval, D., Tannous-Haddad, L. and Wolfson, A.R. (2021), "Sleep quality and COVID-19-related stress in relation to mental health symptoms among Israeli and U.S. adults", *Sleep Health*, Vol. 7 No. 2, pp. 127-133, doi: 10.1016/j.sleh.2021.02.006.

First, J.M., Shin, H., Ranjit, Y.S. and Houston, J.B. (2021), "COVID-19 stress and depression: examining social media, traditional media, and interpersonal communication", *Journal of Loss and Trauma*, Vol. 26 No. 2, pp. 101-115, doi: 10.1080/15325024.2020.1835386.

Havnen, A., Anyan, F., Hjemdal, O., Solem, S., Gurigard Riksfjord, M. and Hagen, K. (2020), "Resilience moderates negative outcome from stress during the COVID-19 pandemic: a moderated-mediation approach", *International Journal of Environmental Research and Public Health*, Vol. 17 No. 18, pp. 1-13, doi: 10.3390/ijerph17186461.

Hawes, M.T., Szenczy, A.K., Klein, D.N., Hajcak, G. and Nelson, B.D. (2021), "Increases in depression and anxiety symptoms in adolescents and young adults during the COVID-19 pandemic", *Psychological Medicine*, Vol. 52 No. 14, pp. 3222-3230, doi: 10.1017/S0033291720005358.

Hayes, A.F., Montoya, A.K. and Rockwood, N.J. (2017), "The analysis of mechanisms and their contingencies: PROCESS versus structural equation modeling", *Australasian Marketing Journal*, Vol. 25 No. 1, pp. 76-81, doi: 10.1016/j.ausmj.2017.02.001.

Hayes, A.F. (2018), *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*, 2nd ed., The Guilford Press, New York.

João, K.A.D.R., Jesus, S.N., de, Carmo, C. and Pinto, P. (2018), "The impact of sleep quality on the mental health of a non-clinical population", *Sleep Medicine*, Vol. 46, pp. 69-73, doi: 10.1016/j. sleep.2018.02.010.

Karasar, B. and Canlı, D. (2020), "Psychological resilience and depression during the Covid-19 pandemic in Turkey", *Psychiatria Danubina*, Vol. 32 No. 2, pp. 273-279, doi: 10.24869/psyd.2020.273.

Kirch, W. (2008), *Encyclopedia of Public Health*, Springer Publishing Co, New York, Vol. 1, pp. 1-1484, doi: 10.1007/978-1-4020-5614-7.

Lakhan, R., Agrawal, A. and Sharma, M. (2020), "Prevalence of depression, anxiety, and stress during COVID-19 pandemic", *Journal of Neurosciences in Rural Practice*, Vol. 11 No. 04, pp. 519-525, doi: 10.1055/s-0040-1716442.

Liu, Q. and Wang, Z. (2021), "Perceived stress of the COVID-19 pandemic and adolescents' depression symptoms: the moderating role of character strengths", *Personality and Individual Differences*, Vol. 182 No. 111062, pp. 1-6, doi: 10.1016/j.paid.2021.111062.

Lovibond, P.F. and Lovibond, S.H. (1995), "The structure of negative emotional states: comparison of the depression anxiety stress scales (DASS) with the beck depression and anxiety inventories", *Behaviour Research and Therapy*, Vol. 33 No. 3, pp. 335-343.

Ngoc Cong Duong, K., Nguyen Le Bao, T., Thi Lan Nguyen, P., Vo Van, T., Phung Lam, T., Pham Gia, A., Anuratpanich, L. and Vo Van, B. (2020), "Psychological impacts of COVID-19 during the first nationwide lockdown in Vietnam: web-based, cross-sectional survey study", *JMIR Formative Research*, Vol. 4 No. 12, pp. 1-10, doi: 10.2196/24776.

Palagini, L., Moretto, U., Novi, M., Masci, I., Caruso, D., Drake, C.L. and Riemann, D. (2018), "Lack of resilience is related to stress-related sleep reactivity, hyperarousal, and emotion dysregulation in insomnia disorder", *Journal of Clinical Sleep Medicine*, Vol. 14 No. 05, pp. 759-766, doi: 10.5664/jcsm.7100.

Porter, C., Favara, M., Hittmeyer, A., Scott, D., Sánchez Jiménez, A., Ellanki, R., Woldehanna, T., Thuc Duc, L., Craske, M.G. and Stein, A. (2021), "Impact of the COVID-19 pandemic on anxiety and

depression symptoms of young people in the global south: evidence from a four-country cohort study", *BMJ Open*, Vol. 11 No. 4, pp. 1-14, doi: 10.1136/bmjopen-2021-049653.

Racine, N., McArthur, B.A., Cooke, J.E., Eirich, R., Zhu, J. and Madigan, S. (2021), "Global prevalence of depressive and anxiety symptoms in children and adolescents during COVID-19", *JAMA Pediatrics*, Vol. 175 No. 11, pp. 1142-1150, doi: 10.1001/jamapediatrics.2021.2482.

Richardson, C., Oar, E., Fardouly, J., Magson, N., Johnco, C., Forbes, M. and Rapee, R. (2019), "The moderating role of sleep in the relationship between social isolation and internalising problems in early adolescence", *Child Psychiatry and Human Development*, Vol. 50 No. 6, pp. 1011-1020.

Rothan, H.A. and Byrareddy, S.N. (2020), "The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak", *Journal of Autoimmunity*, Vol. 109, pp. 1-4, doi: 10.1016/j.jaut.2020.102433.

Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., Rasoulpoor, M. and Khaledi-Paveh, B. (2020), "Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis", *Globalization and Health*, Vol. 16 No. 1, pp. 1-11, doi: 10.1186/s12992-020-00589-w.

Scheier, M.F. and Carver, C.S. (1985), "Optimism, coping, and health: assessment and implications of generalized outcome expectancies", *Health Psychology*, Vol. 4 No. 3, pp. 219-247, doi: 10.1037/0278-6133.4.3.219.

Siddique, R.F., Ahmed, O. and Hossain, K.N. (2021), "Relationship between the fear of COVID-19 disease and sleep quality: the mediating role of stress", *Heliyon*, Vol. 7 No. 5, pp. 1-8, doi: 10.1016/j.heliyon.2021.e07033.

To, N. and Nguyen, N. (2015), "Validity of the Vietnamese version of the Pittsburgh sleep quality index", *Sleep Medicine*, Vol. 16, p. S52.

Tường, N.P.C. and Long, Đ.M. (2016), "Mối liên hệ giữa stress và tinh thần lạc quan của sinh viên trường Đại học Y Dược - Đại học Huế", *Tạp Chí Tâm Lý Học Xã Hội*, Vol. 4 No. 4, pp. 37-42, available at: https://sti.vista.gov.vn/file_DuLieu/dataTLKHCN//CVv413/2016/CVv413S042016037.pdf

Vos, L.M.W., Habibović, M., Nyklíček, I., Smeets, T. and Mertens, G. (2021), "Optimism, mindfulness, and resilience as potential protective factors for the mental health consequences of fear of the coronavirus", *Psychiatry Research*, Vol. 300, pp. 1-8, doi: 10.1016/j.psychres.2021.113927.

Wright, L.J., Williams, S.E. and Veldhuijzen van Zanten, J.J.C.S. (2021), "Physical activity protects against the negative impact of coronavirus fear on adolescent mental health and well-being during the COVID-19 pandemic", *Frontiers in Psychology*, Vol. 12, pp. 1-10, doi: 10.3389/fpsyg.2021.580511.

Wu, D., Yang, T., Hall, D.L., Jiao, G., Huang, L. and Jiao, C. (2021), "COVID-19 uncertainty and sleep: the roles of perceived stress and intolerance of uncertainty during the early stage of the COVID-19 outbreak", *BMC Psychiatry*, Vol. 21 No. 1, pp. 1-11, doi: 10.1186/s12888-021-03310-2.

Yan, L., Gan, Y., Ding, X., Wu, J. and Duan, H. (2021), "The relationship between perceived stress and emotional distress during the COVID-19 outbreak: effects of boredom proneness and coping style", *Journal of Anxiety Disorders*, Vol. 77, pp. 1-11, doi: 10.1016/j.janxdis.2020.102328.

Zhang, Z., Zhai, A., Yang, M., Zhang, J., Zhou, H., Yang, C., Duan, S. and Zhou, C. (2020), "Prevalence of depression and anxiety symptoms of high school students in shandong province during the COVID-19 epidemic", *Frontiers in Psychiatry*, Vol. 11, pp. 1-8, doi: 10.3389/fpsyt.2020.570096.

Corresponding author
Thi Truc Quynh Ho can be contacted at: httquynh@hueuni.edu.vn