

Sleep quality in non-hospitalized medical students after COVID-19 infection in Northern Vietnam

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ABSTRACT

Sleep disorders are among the most commonly reported symptoms following a coronavirus disease 2019 (COVID-19) infection. Medical students, in particular, are highly vulnerable, exhibiting a higher prevalence of poor sleep quality compared to the general population. This study aimed to compare sleep quality between medical students with and without a history of COVID-19 infection and to identify factors associated with poor sleep quality in the infected group. A cross-sectional study was conducted among medical students at a university in Northern Vietnam, with data collected via an online self-administered questionnaire. Sleep quality was assessed using the Sleep Quality Scale (SQS), where higher scores indicate poorer sleep quality. Univariate and multivariate linear regression analyses were performed. Of the 673 participants, 372 (55.3%) had a history of COVID-19 infection, while 301 (44.7%) did not. Students with a history of COVID-19 infection demonstrated significantly poorer sleep quality compared to those without ($p < 0.01$). Among the infected group, poorer sleep quality was significantly associated with younger age (coefficient [coef]: -1.01; 95% confidence interval [CI]: -1.74 to -0.27), female gender (coef: 3.05; 95% CI: 0.11 to 6.00), living with others (coef: 3.12; 95% CI: 0.42 to 5.81), and a longer duration of COVID-19 infection (coef: 6.84; 95% CI: 2.21 to 11.47). These findings underscore the significant burden of sleep disorders among medical students following COVID-19 infection and highlight the importance of early detection and intervention to mitigate long-term consequences.

Keywords:

sleep quality; COVID-19; medical students; Vietnam

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INTRODUCTION

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic.¹ As of April 2022, nearly 490 million cases had been reported worldwide.² In addition to its physical health impacts, COVID-19 has raised significant concerns regarding mental health issues, including anxiety, depression, and sleep disturbances.³ Sleep disturbances, or insomnia, are among the most common symptoms experienced by patients following a COVID-19 infection.^{3,4}

Several factors contribute to sleep disturbances, including female gender, older age, severe illness, socio-economic disadvantages, social isolation, chronic diseases, and comorbid mental health conditions such as anxiety and depression.⁵⁻⁷ In the context of COVID-19, strict lockdown measures, reduced physical activity, and disrupted circadian rhythms often exacerbate these factors.⁷⁻¹¹ Moreover, individuals with a history of COVID-19 infection appear to be at a higher risk of sleep disturbances compared to those without.¹² This may be attributed to psychosocial stressors, such as prolonged symptoms, fear of long-term consequences, isolation, and biological mechanisms. Biologically, SARS-CoV-2 has neurotropic potential and may induce neuroinflammation, dysregulate the hypothalamic-pituitary-adrenal axis, and suppress melatonin production, impairing normal sleep-wake regulation.^{13, 14}

Sleep disorders can lead to significant functional impairments, including reduced productivity, increased healthcare utilization, and a diminished quality of life.^{7, 15, 16} In the post-COVID-19 context, insomnia symptoms have been linked to respiratory difficulties, such as impaired lung function and dyspnea, and can significantly exacerbate mental health issues.¹⁷ Notably, insomnia is a strong

predictor of depression and anxiety, highlighting the importance of early identification and intervention.¹⁸

Due to their heavy academic workload, high expectations, and frequent assessments, medical students are already at an increased risk for sleep problems compared to the general population.^{19, 20} Although some studies have examined sleep quality among medical students during the pandemic,^{21, 22} few have directly compared sleep quality between those with and without a history of COVID-19 infection. Therefore, this study aimed to compare sleep quality between medical students with and without a history of COVID-19 infection and to identify factors associated with poor sleep quality among the infected group.

MATERIALS AND METHODS

Study Design and Participants

A cross-sectional study was conducted on medical students at Hai Phong University of Medicine and Pharmacy, one of Vietnam's eight major medical training universities. Participants were categorized into two groups based on their COVID-19 infection status: (1) medical students diagnosed with COVID-19 (regardless of vaccination status and not hospitalized for COVID-19 treatment) and (2) medical students without a history of COVID-19 infection. COVID-19 diagnosis was confirmed via rapid antigen tests (RAT) or real-time reverse transcription-polymerase chain reaction (RT-PCR). Participants were excluded if they: (1) were currently infected with COVID-19, (2) had a history of diagnosed sleep or mental health disorders, or (3) refused to participate in the research.

Sample Size

The sample size for the study was determined based on interval estimates with

a single sample to ascertain an average value:

$$n = \frac{Z^2_{1-\frac{\alpha}{2}} \sigma^2}{\varepsilon^2 \mu^2}$$

Where: n = minimum research sample size; σ = reference standard deviation (SD; $\sigma = 12.22$); μ = average value of sleep quality score ($\mu = 28.89$);²³ ε = relative error ($\varepsilon = 0.05$); α = statistical significance level ($\alpha = 0.05$). The minimum required sample size was calculated to be 275. Anticipating a 20% data loss or ineligible participants, the adjusted sample size was increased to 344. Thus, the minimum sample size was established as 344 individuals for the group with a history of COVID-19 infection. During data collection, 372 individuals with COVID-19 infection participated in the survey and met the criteria for analysis. To compare sleep quality between the infected and non-infected groups, data were collected from 301 individuals without COVID-19 infection who met the study criteria. The total number of participants was 673. Data were collected through an online survey distributed to all university students between April and May 2022.

Variables and Measurements

Dependent variable: Sleep quality of the participants was assessed using the SQS.²⁴ The SQS consists of 28 items evaluating six domains of sleep quality: daytime dysfunction (12 items), restoration after sleep (4 items), difficulty in falling asleep (4 items), difficulty in maintaining sleep (2 items), sleep satisfaction (3 items), and difficulty in getting up (3 items). Using a 4-point Likert scale, respondents indicated how frequently they exhibited certain sleep behaviors (0 = “few,” 1 = “sometimes,” 2 = “often,” and 3 = “almost always”). The items related to “restoration after sleep” and “sleep satisfaction” were reverse-scored. Total scores can range from 0 to 84, with higher scores indicating more severe sleep issues. Sleep quality problems

are categorized into three levels: mild (scores from 0 to 28), moderate (scores from 29 to 56), and severe (scores from 57 to 84).²³ In this study, the reliability of the scale was high, with a Cronbach’s alpha coefficient of 0.869.

Independent variables included socio-demographic information: age, gender, residence, living status, weight, height, part-time job, study pressure, and disease status. Lifestyle-related factors included daily physical activity, smoking, and alcohol consumption over the last 12 months. Information regarding COVID-19 infection encompassed the duration of COVID-19 infection, COVID-19 symptoms, treatment methods, post-COVID-19 infection period, symptoms after COVID-19 infection, and self-reported health status following COVID-19 infection. Self-reported weight and height were collected to calculate Body Mass Index (BMI), which was then classified into three categories: underweight (BMI < 18.5 kg/m²), normal (BMI: 18.5–24.9 kg/m²), and overweight/obesity (BMI: ≥ 25.0 kg/m²).²⁵ The duration of COVID-19 infection was measured from the time the participant tested positive for COVID-19 via PCR/rapid test until they tested negative. The post-COVID-19 infection period was calculated from the time the participant tested negative until the study period.

COVID-19 symptoms were categorized as follows: systemic symptoms (fever, hair loss, fatigue, chills); digestive symptoms (digestive disorders, nausea, or vomiting); sensory symptoms (loss of taste, impaired sense of smell); respiratory symptoms (cough, sore throat, runny nose, difficulty breathing); musculoskeletal symptoms (muscle pain or body aches); and neurological symptoms (headache, decreased memory).

Statistical Analysis

The Excel file extracted from Google Forms was converted into a .sav (SPSS data file). All analyses were performed using SPSS version 25.0. We reported frequencies and percentages (%) for categorical variables, while continuous variables were presented as means, medians, and standard deviations (SDs). The Chi-square test or Fisher's exact test was used to compare differences in proportions between the COVID-19-infected and non-infected groups across various factors. Differences in sleep quality scores and associated factors were analyzed using the Independent Sample t-test, Mann-Whitney U test (for two groups), One-way ANOVA test, or Kruskal-Wallis H test (for more than two groups). We conducted univariate and multivariate linear regression analyses to investigate potential associations between sleep quality and various factors. Variables that

demonstrated a *p*-value of less than 0.2 in the univariate linear regression analysis were included in the multivariable linear regression analyses.²⁶ A *p*-value of less than 0.05 was considered statistically significant. We examined the existence of multicollinearity through the Variance Inflation Factor (VIF) and the Tolerance value.

RESULTS

Among 673 participants, the percentages of those infected and non-infected with COVID-19 were 55.3% and 44.7%, respectively. No significant differences were found between the two groups regarding demographic characteristics and lifestyle factors, except for the mean BMI, which differed significantly (Table 1).

Table 1. The demographic and lifestyle factors of the participants

Variables	COVID-19 infection		Total (N = 673)	p
	Yes (N = 372)	No (N = 301)		
Age (in year)	20.75 ± 1.65	20.81 ± 2.03	20.77 ± 3.34	0.735
19 – 20	196 (52.7)	166 (55.1)	362 (53.8)	
21 – 22	115 (30.9)	81 (26.9)	196 (29.1)	
23 or higher	61 (16.4)	54 (17.9)	115 (17.1)	
Gender				0.645
Male	77 (20.7)	58 (19.3)	135 (20.1)	
Female	295 (79.3)	243 (80.7)	538 (79.9)	
Residence				0.529
Private house	70 (18.8)	51 (16.9)	121 (18.0)	
Dormitory/bedsit	302 (81.2)	250 (83.1)	552 (82.0)	
Living status				0.211
Alone	101 (27.2)	95 (31.6)	196 (29.1)	
Living with family/others	271 (72.8)	206 (68.4)	477 (70.9)	
Body mass index (kg/m ²)	20.17 ± 2.72	19.74 ± 2.54	19.98 ± 2.64	0.059
Underweight (< 18.5)	108 (29.0)	104 (34.6)	212 (31.5)	
Normal (18.5 - 24.9)	246 (66.1)	189 (62.8)	435 (64.6)	
Overweight/obesity (≥ 25.0)	18 (4.8)	8 (2.7)	26 (3.9)	
Part-time job				0.528
Yes	136 (36.6)	103 (34.2)	239 (35.5)	
No	236 (63.4)	198 (65.8)	434 (64.5)	

Variables	COVID-19 infection		Total (N = 673)	p
	Yes (N = 372)	No (N = 301)		
Study pressure				0.313
Yes	195 (52.4)	146 (48.5)	341 (50.7)	
No	177 (47.6)	155 (51.5)	332 (49.3)	
Existing medical disease				0.803
Yes	38 (10.2)	29 (9.6)	606 (90.0)	
No	334 (89.8)	272 (90.4)	67 (10.0)	
Daily physical activity				0.281
Yes	160 (43.0)	142 (47.2)	302 (44.9)	
No	212 (57.0)	159 (52.8)	371 (55.1)	
Smoking				0.917
No or former	365 (98.1)	295 (98.0)	660 (98.1)	
Yes	7 (1.9)	6 (2.0)	13 (1.9)	
Alcohol consumption during the last 12 months				0.290
No or less than 1 time/month	338 (90.9)	266 (88.4)	604 (89.7)	
1 – 3 times/month or ≥ 1 time/week	34 (9.1)	35 (11.6)	69 (10.3)	
Using electronic devices before sleeping				0.348
Yes	365 (98.1)	292 (97.0)	657 (97.6)	
No	7 (1.9)	9 (3.0)	16 (2.4)	

Data presented as mean ± standard deviation for continuous variables and frequency and percentage (%) for categorical variables; COVID-19, coronavirus disease 2019; *p*-value was calculated using Chi-square test, T-test, or Wilcoxon-Mann Whitney test.

Most respondents (68.8%) experienced a COVID-19 infection lasting 7–10 days. The majority reported systemic symptoms (90.1%) and respiratory symptoms (96.8%). Among the respondents, 97.6% utilized treatments for COVID-19. Most participants

indicated a post-COVID-19 infection period lasting 4–12 weeks (88.2%). Post-COVID-19 symptoms were reported by 38.7% of respondents, and 54.8% self-reported a worse health status than before the infection (Table 2).

Table 2. The characteristics related to COVID-19 of participants

Variables	N (%)
Number of days infected	
< 7 days	80 (21.5)
7 – 10 days	256 (68.8)
> 10 days	36 (9.7)
Symptom of COVID-19 infection	
Systemic symptoms	335 (90.1)
Respiratory symptoms	360 (96.8)
Musculoskeletal symptoms	246 (66.1)
Digestive symptoms	90 (24.2)
Neurological symptoms	272 (73.1)
Sensory symptoms	48 (12.9)
COVID-19 treatment	
Yes	363 (97.6)
No	9 (2.4)
Treatment methods	
Vitamin	313 (84.1)

Variables	N (%)
Paracetamol	260 (69.9)
Antibiotic	238 (64.0)
Anti-inflammatory corticosteroids	39 (10.5)
Time after COVID-19 infection	
< 4 weeks	26 (7.0)
4 – 12 weeks	328 (88.2)
> 12 weeks	18 (4.8)
Symptoms after COVID-19 infection	
Yes	144 (38.7)
No	228 (61.3)
Health status after COVID-19 infection	
No change	168 (45.2)
Worse than before	204 (54.8)
COVID-19, coronavirus disease 2019	

The sleep quality scores had a median (IQR) of 31.0 (21.3–39.0) in the COVID-19-infected group and 25.0 (18.0–34.5) in the non-infected group. A statistically significant difference in sleep quality scores was observed between the two groups ($p < 0.01$). In both groups, most participants experienced mild to moderate

sleep quality issues. The proportions of participants in the COVID-19-infected group with mild, moderate, and severe sleep quality issues were 43.3%, 55.1%, and 1.6%, respectively. In the non-infected group, these proportions were 52.2%, 46.5%, and 1.3%, respectively (Table 3).

Table 3. Comparison of sleep quality score between groups

Domain	COVID-19 infection		p
	Yes	No	
Daytime dysfunction	11.75 ± 6.93 (0 – 36)	10.62 ± 6.38 (0 – 29)	0.030
Restoration after sleep	5.48 ± 2.56 (0 – 12)	5.18 ± 2.47 (0 – 12)	0.122
Difficulty in falling asleep	3.34 ± 2.49 (0 – 12)	2.85 ± 2.42 (0 – 10)	0.010
Difficulty in maintaining sleep	2.01 ± 1.47 (0 – 6)	1.72 ± 1.39 (0 – 6)	0.010
Sleep satisfaction	3.81 ± 1.89 (0 – 8)	3.48 ± 1.70 (0 – 8)	0.019
Difficulty in getting up	4.10 ± 1.89 (0 – 9)	3.85 ± 2.07 (0 – 9)	0.098
Overall mean score	30.48 ± 12.29 (1 – 64)	27.69 ± 11.22 (0 – 62)	0.002
Sleep quality problems			
Mild (0 – 28)	161 (43.3)	157 (52.2)	0.072
Moderate (29 – 56)	205 (55.1)	140 (46.5)	
Severe (57 – 84)	6 (1.6)	4 (1.3)	

Data presented as mean ± standard deviation (range) for continuous variables and frequency and percentage (%) for categorical variables; COVID-19, coronavirus disease 2019; p -value was calculated using Fisher's exact test, T-test or Wilcoxon-Mann Whitney test.

In the COVID-19-infected group, statistically significant differences were found between sleep quality scores and factors such as age ($p < 0.001$), living status ($p < 0.01$), duration of COVID-19 infection

($p < 0.05$), having musculoskeletal symptoms ($p < 0.01$), and using antibiotics for COVID-19 treatment ($p < 0.05$). In the non-infected group, statistically significant differences in average sleep quality scores

were associated with study pressure ($p < 0.01$), daily physical activity ($p < 0.05$), and using electronic devices before sleeping ($p < 0.05$). Notable differences in sleep quality scores between the COVID-19-infected and non-infected groups were also observed among the 19–20 age group ($p < 0.01$), females ($p < 0.01$), those living in dormitories or bedsits ($p < 0.05$), those living with family or others ($p < 0.001$), individuals with underweight status ($p <$

0.01), those lacking a part-time job ($p < 0.01$), individuals without study pressure ($p < 0.01$), those without existing medical conditions ($p < 0.01$), daily physical activity ($p < 0.05$), non-smokers or former smokers ($p < 0.01$), and those who did not consume alcohol or consumed it less than once a month ($p < 0.01$), as well as those who used electronic devices before sleeping ($p < 0.01$) (Table 4).

Table 4. Sleep quality score according to characteristics of participants

Variables	COVID-19 infection				p^b
	Yes	p^a	No	p^a	
Age (in year)					
19 – 20	32.23 ± 11.95	< 0.001	28.34 ± 10.81	0.102	0.003
21 – 22	31.33 ± 11.27		28.33 ± 12.52		0.129
23 or higher	24.95 ± 11.34		24.74 ± 10.06		0.872
Gender					
Male	27.14 ± 10.41	0.003	28.02 ± 9.80	0.808	0.996
Female	31.44 ± 12.19		27.62 ± 11.55		0.001
Residence					
Private house	32.76 ± 11.56	0.120	28.00 ± 11.87	0.831	0.041
Dormitory/bedsit	30.30 ± 11.95		27.63 ± 11.10		0.019
Living status					
Alone	27.75 ± 12.51	0.002	28.74 ± 12.02	0.204	0.467
Living with family/others	31.88 ± 11.49		27.05 ± 10.67		< 0.001
Body mass index (kg/m ²)					
Underweight	32.18 ± 11.84	0.299	27.33 ± 11.66	0.854	0.005
Normal	30.28 ± 12.02		27.83 ± 10.90		0.058
Overweight/obesity	28.78 ± 10.38		29.38 ± 14.06		0.870
Part-time job					
Yes	30.31 ± 11.91	0.594	27.95 ± 11.50	0.775	0.155
No	31.01 ± 11.91		27.56 ± 11.09		0.007
Study pressure					
Yes	31.70 ± 11.81	0.075	29.82 ± 10.98	0.001	0.237
No	29.72 ± 11.95		25.69 ± 11.02		0.003
Existing medical disease					
Yes	33.00 ± 10.33	0.164	28.59 ± 13.27	0.653	0.177
No	30.51 ± 12.06		27.60 ± 11.00		0.006
Daily physical activity					
Yes	30.53 ± 12.06	0.639	23.26 ± 10.86	0.031	0.005
No	30.94 ± 11.81		28.13 ± 11.18		0.024
Smoking					
No or former	30.78 ± 11.93	0.887	27.71 ± 11.26	0.850	0.003
Yes	29.43 ± 11.37		26.83 ± 9.64		0.627
Alcohol consumption during the last 12 months					
No or less than 1 time/month	31.25 ± 12.56	0.343	28.03 ± 11.17	0.148	0.006
1 – 3 times/month or ≥ 1 time/week	28.68 ± 12.17		25.11 ± 11.38		0.239

Variables	COVID-19 infection				p ^b
	Yes	p ^a	No	p ^a	
Using electronic devices before sleeping					
Yes	30.75 ± 11.86	0.691	35.44 ± 8.34	0.035	0.001
No	31.29 ± 14.94		27.46 ± 11.22		0.412
Number of days infected					
< 7 days	27.51 ± 10.10	0.002			
7 – 10 days	31.10 ± 11.97				
> 10 days	35.58 ± 13.35				
Symptom groups of COVID-19 infection					
Systemic symptoms (Yes vs. No)	30.73 ± 11.84	0.875			
Respiratory symptoms (Yes vs. No)	30.77 ± 11.91	0.958			
Musculoskeletal symptoms (Yes vs. No)	32.04 ± 12.53	0.009			
Digestive symptoms (Yes vs. No)	30.80 ± 13.38	0.959			
Neurological symptoms (Yes vs. No)	30.88 ± 11.67	0.753			
Sensory symptoms (Yes vs. No)	32.21 ± 11.07	0.299			
COVID-19 treatment					
Yes	30.70 ± 11.98	0.509			
No	33.11 ± 8.61				
Treatment methods					
Vitamins (Yes vs. No)	31.04 ± 12.19	0.301			
Paracetamol (Yes vs. No)	30.72 ± 12.27	0.928			
Antibiotics (Yes vs. No)	31.91 ± 12.27	0.053			
Anti-inflammatory corticosteroids (Yes vs. No)	33.85 ± 11.28	0.085			
Time after COVID-19 infection					
< 4 weeks	33.23 ± 9.64	0.410			
4 – 12 weeks	30.57 ± 11.97				
> 12 weeks	30.61 ± 13.76				
Symptoms after COVID-19 infection					
Yes	31.74 ± 12.14	0.164			
No	30.14 ± 11.74				
Health status after COVID-19 infection					
No change	31.13 ± 11.19	0.414			
Worse than before	30.46 ± 12.48				

Data was presented as mean/median and standard deviation (Mean ± SD); COVID-19, coronavirus disease 2019; SQS, sleep quality scale; *p*-value was calculated using T-test or Wilcoxon-Mann Whitney test (2 groups) and the One-way ANOVA or Kruskal-Wallis test (multiple groups); p^a, compare between within-group; p^b, compare between two groups.

A significant relationship was found between sleep quality and age (coef, -1.01; 95% CI, -1.74 to -0.27), gender (coef, 3.05; 95% CI, 0.11 to 6.00), living status (coef, 3.12; 95% CI, 0.42 to 5.81), and duration of COVID-19 infection (coef, 6.84; 95% CI, 2.21 to 11.47) (Table 5).

DISCUSSION

Our findings revealed that individuals infected with COVID-19 experienced significantly poorer sleep quality compared to those who were not infected. Factors associated with worse sleep quality included older age, female gender, living with others, and a longer duration of infection.

Numerous studies have reported sleep quality issues among students during lockdown periods; however, very few have

explored sleep quality in students following a positive COVID-19 diagnosis. A comprehensive analysis incorporating data from 13 countries has shown a high global prevalence of sleep problems, with individuals affected by COVID-19 being the most impacted group.²⁷ Most studies commonly utilize the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality. However, we opted to employ the SQS in this study, as it may provide a more comprehensive evaluation than other scales, such as the PSQI, by incorporating questions regarding individuals' daytime functioning and well-being after experiencing restful sleep.²⁸

This study indicated demographic characteristics and lifestyle habits were similar between the COVID-19-infected and non-infected groups. We found that overall sleep quality scores, as well as scores in some domains of the SQS, were higher in the COVID-19-infected group compared to the non-infected group, indicating poorer sleep quality among the infected group. This could be attributed to the lingering effects of post-COVID-19 symptoms, including fatigue and sleep disturbances, as reported in previous studies. These studies have shown that individuals with COVID-19, even those who did not require hospitalization, experience more difficulties with sleep compared to the non-infected group.^{6, 29}

The results revealed that the majority of the participants experienced sleep quality issues ranging from mild to moderate. This finding aligns with a study conducted in India, where nearly 97% of participants reported mild to moderate sleep quality problems using the SQS measurement scale.²³ A study conducted on individuals who contracted COVID-19 in the community in Vietnam also found that up to 75% reported experiencing sleep disturbances following the illness.⁶ Other studies have similarly reported the prevalence of sleep problems or poorer sleep quality among individuals post-

COVID-19.^{6, 30, 31} Various factors can contribute to decreased sleep quality among these patients. The illness itself exacerbates already high levels of stress due to social distancing, quarantine measures, and travel restrictions, all of which significantly contribute to the development of sleep disturbances.³² We suggest that individuals who have recovered from COVID-19 should be screened for persistent symptoms. Those reporting sleep disorders should receive treatment for any underlying causes, with options including melatonin, benzodiazepines, and zolpidem, which can be appropriately adjusted for each individual.³⁰

This current study demonstrated a significant association between age and sleep quality scores in the COVID-19-infected group, with older age correlating with lower sleep quality scores (indicating better sleep quality). This finding aligns with other studies that have reported similar results.³³⁻³⁵ A plausible explanation for this phenomenon is that older medical students may not experience excessive anxiety when contracting COVID-19, thanks to their accumulated clinical experience in hospitals, which allows them to maintain better sleep quality. In contrast, students in their early years, who primarily focus on theoretical learning, may experience higher levels of anxiety upon contracting COVID-19, leading to difficulties in maintaining good sleep quality.

In the COVID-19-infected group, we found a significant relationship between gender and sleep quality, with males exhibiting better sleep quality compared to females. This finding aligns with other research studies.^{27, 33} Various factors, such as immune response to COVID-19 infection and inherent differences in brain structure between genders, may influence the disparities in sleep disorders observed between males and females.³⁶ Additionally, research indicates that female students tend to experience higher levels of anxiety and stress.³⁷

Our study revealed a relationship between living status and sleep quality in the COVID-19-infected group, indicating that individuals living with family or others experience poorer sleep quality than those living alone. We did not find similar results in existing literature. However, we believe that factors such as noise, light, differing sleep habits, and concerns about virus transmission can disrupt sleep and diminish sleep quality for those living with others.

This research demonstrates that longer durations of COVID-19 infection are associated with poorer sleep quality. Individuals infected with COVID-19 for an extended period (over 10 days) report worse sleep quality compared to those infected for a shorter duration (under seven days). This can be attributed to symptoms and manifestations associated with COVID-19, such as cough, shortness of breath, and fatigue, which can hinder sleep and reduce overall sleep quality. However, findings by Duong-Quy et al. did not establish a statistically significant correlation between the duration of COVID-19 infection and sleep quality.³¹ This suggests an opposite trend between studies, indicating that further research is needed to clarify this issue better.

This study has several limitations. Firstly, it is important to note that this is a cross-sectional study, which limits our ability to establish a cause-and-effect relationship between the identified factors and participants' sleep quality. Secondly, data collection through self-report questionnaires introduces the potential for social desirability and recall biases. Thirdly, this study did not account for certain variables identified in previous research as potential factors affecting sleep quality, such as tea and coffee consumption habits and mental health issues. Finally, we were unable to determine participants' sleep quality at different times due to the

lack of baseline data for the students prior to the COVID-19 pandemic.

CONCLUSIONS

This study provides evidence of significantly poorer sleep quality among medical students in Vietnam following COVID-19 infection. Among those infected, younger age, female gender, living with others, and longer duration of infection were significantly associated with worse sleep quality. These findings underscore the importance of early identification and management of sleep disturbances in this vulnerable group. Tailored interventions from healthcare providers and policymakers are essential to mitigate the long-term impacts of COVID-19 on students' sleep health.

AUTHORS' CONTRIBUTION

Thao Thi Thu Nguyen: Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing. Thinh Cuong Dao: Conceptualization, Data curation. Binh Thi Thanh Nguyen: Conceptualization, Methodology. Duc Minh Cap: Formal analysis, Writing – original draft, Writing – review & editing.

ETHICAL CONSIDERATION

The Ethics Committee of Haiphong University of Medicine and Pharmacy in Vietnam approved the study protocol (Ethics Approval No. 225/QĐ-YDHP, dated January 21, 2022). To ensure informed consent, participants were required to complete a consent form, indicating their agreement by selecting the “Yes, I agree” option on an online platform

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest in this study.

REFERENCES

1. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020 [Internet]. [Cited December 10, 2024]. Available from: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>.
2. World Health Organization. WHO Coronavirus (COVID-19) Dashboard 2022 [Internet]. [Cited December 15, 2024]. Available from: <https://covid19.who.int>.
3. Bourmistrova NW, Solomon T, Braude P, Strawbridge R, Carter B. Long-term effects of COVID-19 on mental health: A systematic review. *J Affect Disord*. 2022;299:118-25.
4. Almas T, Malik J, Alsubai AK, Jawad Zaidi SM, Iqbal R, Khan K, et al. Post-acute COVID-19 syndrome and its prolonged effects: An updated systematic review. *Ann Med Surg (Lond)*. 2022;80:103995.
5. Gui Z, Wang YY, Li JX, Li XH, Su Z, Cheung T, et al. Prevalence of poor sleep quality in COVID-19 patients: a systematic review and meta-analysis. *Front Psychiatry*. 2024 14:1272812.
6. Hoang HTX, Yeung WF, Truong QTM, Le CT, Bui ATM, Bui QV, et al. Sleep quality among non-hospitalized COVID-19 survivors: a national cross-sectional study. *Front Public Health*. 2024;11:1281012.
7. Zhong Y, Ji Q, Zhou L. Sleep disorders of post-COVID-19 conditions. *Sleep Breath*. 2023;27(6):2435-6.
8. Barateau L, Chenini S, Rassu AL, Denis C, Lorber Q, Dhalluin C, et al. Changes in sleep pattern during the COVID-19 lockdown in patients with narcolepsy, idiopathic hypersomnia, and restless legs syndrome. *Neurology*. 2022;99:E1475–e85.
9. Burks SM, Rosas-Hernandez H, Alejandro Ramirez-Lee M, Cuevas E, Talpos JC. Can SARS-CoV-2 infect the central nervous system via the olfactory bulb or the blood-brain barrier? *Brain Behav Immun*. 2021;95:7-14.
10. Mayi BS, Leibowitz JA, Woods AT, Ammon KA, Liu AE, Raja A. The role of Neuropilin-1 in COVID-19. *PLoS Pathog*. 2021;17(1):e1009153.
11. Yuksel D, McKee GB, Perrin PB, Alzueta E, Caffarra S, Ramos-Usuga D, et al. Sleeping when the world locks down: Correlates of sleep health during the COVID-19 pandemic across 59 countries. *Sleep Health*. 2021;7(2):134-42.
12. Kalamara E, Pataka A, Boutou A, Panagiotidou E, Georgopoulou A, Ballas E, et al. Persistent Sleep Quality Deterioration among Post-COVID-19 Patients: Results from a 6-Month Follow-Up Study. *J Pers Med*. 2022;12(11):1909.
13. Karkala A, Tzinis A, Kotoulas S, Zacharias A, Sourla E, Pataka A. Neuropsychiatric Outcomes and Sleep Dysfunction in COVID-19 Patients: Risk Factors and Mechanisms. *Neuroimmunomodulation*. 2023;30(1):237-49.
14. Tedjasukmana R, Budikayanti A, Islamiyah WR, Witjaksono AMAL, Hakim M. Sleep disturbance in post COVID-19 conditions: Prevalence and quality of life. *Front Neurol*. 2023;13:1095606.
15. El Sayed S, Gomaa S, Shokry D, Kabil A, Eissa A. Sleep in post-COVID-19 recovery period and its impact on different domains of quality of life. *Egypt J Neurol Psychiatry Neurosurg*. 2021;57:172.
16. Pizzonia KL, Koscinski B, Suhr JA, Accorso C, Allan DM, Allan NP. Insomnia during the COVID-19 pandemic: The role of depression and COVID-19-related risk factors. *Cogn Behav Ther*. 2021;50:246–60.

17. Jackson C, Stewart ID, Plekhanova T, Cunningham PS, Hazel AL, Al-Sheklly B, et al. Effects of sleep disturbance on dyspnoea and impaired lung function following hospital admission due to COVID-19 in the UK: a prospective multicentre cohort study. *Lancet Respir Med* 2023 11(8):673-84.
18. Hertenstein E, Feige B, Gmeiner T, Kienzler C, Spiegelhalder K, Johann A, et al. Insomnia as a predictor of mental disorders: a systematic review and meta-analysis. *Sleep Med Rev*. 2019;43:96–105.
19. Azad MC, Fraser K, Rumana N, Abdullah AF, Shahana N, Hanly PJ, et al. Sleep disturbances among medical students: a global perspective. *J Clin Sleep Med*. 2015;11(1):69-74.
20. Lima PF, Medeiros ALD, Rolim SAM, Dias Júnior SA, Almondes KM, Araújo JF. Changes in sleep habits of medical students according to class starting time: a longitudinal study. *Sleep Sci*. 2009;2(2):92–5.
21. Huang W, Wen X, Li Y, Luo C. Association of perceived stress and sleep quality among medical students: the mediating role of anxiety and depression symptoms during COVID-19. *Front Psychiatry*. 2024;15:1272486.
22. Tahir MJ, Malik NI, Ullah I, Khan HR, Perveen S, Ramalho R, et al. Internet addiction and sleep quality among medical students during the COVID-19 pandemic: A multinational cross-sectional survey. *PLoS One*. 2021;16(11):e0259594.
23. John B, Marath U, Valappil SP, Mathew D, Renjitha M. Sleep Pattern Changes and the Level of Fatigue Reported in a Community Sample of Adults During COVID-19 Pandemic. *Sleep Vigil*. 2022;6(2):297-312.
24. Yi H, Shin K, Shin C. Development of the sleep quality scale. *J Sleep Res*. 2006;15(3):309-16.
25. World Health Organization. Obesity: Preventing and managing the global epidemic: Report of a WHO consultation 2000 [Internet]. [Cited December 23, 2024]. Available from: <https://iris.who.int/handle/10665/42330>.
26. Maldonado G, Greenland S. Simulation study of confounder-selection strategies. *Am J Epidemiol*. 1993;138(11):923-36.
27. Jahrami H, BaHammam AS, Bragazzi NL, Saif Z, Faris M, Vitiello MV. Sleep problems during the COVID-19 pandemic by population: a systematic review and meta-analysis. *J Clin Sleep Med*. 2021; 17:299–313.
28. Snyder E, Cai B, DeMuro C, Morrison MF, Ball W. A New Single-Item Sleep Quality Scale: Results of Psychometric Evaluation in Patients With Chronic Primary Insomnia and Depression. *J Clin Sleep Med*. 2018; 14(11):1849-57.
29. Donzella SM, Kohler LN, Crane TE, Jacobs ET, Ernst KC, Bell ML, et al. COVID-19 Infection, the COVID-19 Pandemic, and Changes in Sleep. *Front Public Health*. 2022;9:795320.
30. Choudhry AA, Shahzeen F, Choudhry SA, Batool N, Murtaza F, Dilip A, et al. Impact of COVID-19 Infection on Quality of Sleep. *Cureus*. 2021;13(9):e18182.
31. Duong-Quy S, Tang-Thi-Thao T, Huynh-Truong-Anh D, Hoang-Thi-Xuan H, Nguyen-Van T, Nguyen-Tuan A, et al. Sleep Disorders in Patients with Severe COVID-19 Treated in the Intensive Care Unit: A Real-Life Descriptive Study in Vietnam. *Discov Med*. 2024;36(183):690-8.
32. Kokou-Kpolou CK, Megalakaki O, Laimou D, Kousouri M. Insomnia during COVID-19 pandemic and lockdown: Prevalence, severity, and associated risk factors in French population. *Psychiatry Res*. 2020;290:113128.
33. Bajaj S, Blair KS, Schwartz A, Dobbertin M, Blair RJR. Worry and insomnia as risk factors for depression during initial stages of COVID-19 pandemic in India. *PLoS One*. 2020;15(12):e0243527.
34. Kaparounaki CK, Patsali ME, Mousa DV, Papadopoulou EVK, Papadopoulou KKK, Fountoulakis KN. University students' mental health amidst the COVID-19 quarantine in Greece. *Psychiatry Res*. 2020;290:113111.
35. Marelli S, Castelnuovo A, Somma A, Castronovo V, Mombelli S, Bottoni D, et al. Impact of COVID-19 lockdown on sleep

- quality in university students and administration staff. *J Neurol.* 2021; 268(1):8-15.
36. Xin J, Zhang Y, Tang Y, Yang Y. Brain Differences Between Men and Women: Evidence from Deep Learning. *Front Neurosci.* 2019;13:185.
37. Batra K, Sharma M, Batra R, Singh TP, Schvaneveldt N. Assessing the psychological impact of COVID-19 among college students: an evidence of 15 countries. *Healthcare.* 2021;9:222