

REVIEW ARTICLE

Sleep Quality Of College Students During COVID-19 Outbreak In China: A Cross-Sectional Study

Rui Wang, MD; Lianping He, PhD; Baohong Xue, PhD; Xiuxiu Wang, MD; Sheng Ye, PhD

ABSTRACT

Introduction • Poor sleep quality among college students is a global problem. Chinese college students were required to home quarantine, social distance and participate in online learning during the COVID-19 epidemic. This study aimed to investigate the sleep quality of college students during the epidemic and identify the factors related to poor sleep quality.

Methods • Study participants completed an online survey that included questionnaires about sleep symptoms and lifestyle during the COVID-19 outbreak. The study participants included 3416 college students (mean age 20.4 ± 1.8 years). The Pittsburgh Sleep Quality Index (PSQI) was used to measure sleep quality, and a PSQI score >7 was defined as poor sleep quality. A logistic regression model was used to analyze the factors related to sleep quality.

Results • The percentage of college students with poor sleep quality was 15.97 % in southern Anhui province during the COVID-19 pandemic. The majority of the students were female (67.4%) and most were from urban areas (53.9%). Single-parent (adjusted odds ratio [aOR], 1.39; 95% CI, 1.02-1.89) domestic violence incidents $\geq 5 \times /yr$ (aOR, 3.68; 95% CI, 1.70 to 7.96), nap time >4 hr/d

(aOR, 1.90; 95% CI, 25-2.90) were significantly associated with poor sleep quality. While knowledge of COVID-19 was prevalent (aOR, 0.71; 95% CI, 0.53 to 0.96) light exercise >1 hour/day (aOR, 0.47; 95% CI, 0.28 to 0.78), parent-accompanied exercise $>3 \times /wk$ (aOR, 0.59; 95% CI, 0.38 to 0.90) were protective factors against poor sleep quality.

Conclusions • The present study found that college students in single-parent families and students who had experienced domestic violence had a high risk of poor sleep quality during the COVID-19 pandemic in China. College students who were familiar with COVID-19 and had light exercise habits or parent-accompanied exercise habits had better sleep quality.

At the time of writing, COVID-19 was still pandemic worldwide, so targeted sleep health interventions must be established to actively guide college students' healthy living habits. In addition, the sleep disorders and other health problems that may occur in college students should be dealt with in advance, and should be part of the routine work of global disease prevention. (*Altern Ther Health Med.* 2022;28(3):58-64).

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INTRODUCTION

Sleep is a crucial element of health and has an important effect on bodily systems.¹ A variety of mental health symptoms have been confirmed as being closely related to sleep quality.^{2,3} Recent research has shown that sleep repairs neuron DNA, which may slow neuron aging.⁴ Adequate sleep plays a vital role in learning and memory processing among college students,⁵ and good sleep quality is strongly associated with good academic performance.⁶ On the other hand, poor sleep quality is a risk factor for mental health issues and can result in negative emotions.⁷ Moreover, poor sleep quality increases the risk for accidents at work and affects academic performance.⁸ Evidence indicates a significant link between depression and poor sleep quality.⁹

Since the outbreak of COVID-19 in China at the end of 2019, a total of 81 846 positive cases and 3287 deaths had been confirmed in China as of March 25, 2020.¹⁰ During the COVID-19 pandemic, many countries implemented home quarantine measures, and thus the public's living habits, study and work practices have changed.¹¹⁻¹⁵ It has been shown that sudden outbreaks, rising death counts and interruptions in social life have all contributed to a significant decline in sleep quality.¹¹⁻¹³ In addition, COVID-19 can itself lead to poor sleep quality, which hurts physical and mental health.^{7,15}

One indirect effect of the COVID-19 pandemic is it results in negative moods by affecting the sleep quality of college students.⁷ College students are a special group of people who are in the critical transition from adolescence to adulthood.¹⁶ Poor sleep quality in college students is a common problem worldwide.¹⁷ Chinese college students were required to home quarantine, social distance and participate in online learning during the COVID-19 outbreak. These changes may interfere with their sleep quality, which should be of concern. However, although some studies have investigated the sleep quality of middle school students during COVID-19,¹⁸ and some researchers have investigated the mental health of college students after the end of home quarantine,¹⁹ there are few studies on the sleep quality of college students during COVID-19 in China, and its related influences are not clear.

Therefore, we collected a large sample of online surveys to investigate the sleep quality of college students during COVID-19 and identify the factors related to poor sleep quality.

MATERIALS AND METHODS

Study Design

Our study was cross-sectional in design and convenience sampling was used from March 1 to 12, 2020, approximately 1 month after the COVID-19 outbreak in China. We collected data on demographic characteristics, lifestyle, exercise habits, knowledge of COVID-19 and assessment of sleep quality in students from 8 colleges and universities (Anhui Institute of Information Technology, Anhui Polytechnic University, Wannan Medical College, Anhui Normal University, Anhui Technical College of Mechanical and Electrical Engineering, Anhui Technical College of Mechanical and Electrical Engineering, XuanCheng Vocational & Technical College and Chaohu University) via the business online survey platform SurveyStar (Changsha Ranxing Science and Technology, China) in southern Anhui province, China. The study was approved by the Medical Ethics Committee of the Second Affiliated Hospital of Wannan Medical College, China.

The survey had 3 parts. The first part gathered demographic information, including gender, age, body mass index (BMI), study major, residence, single or 2 parents, parental occupation, marital status, smoking status, domestic violence, grade rankings, student cadre and participation in interest groups at school. The second part investigated

individuals' lifestyle and knowledge of COVID-19 during the home quarantine period, including knowledge of COVID-19, living in a gated community or not, living with family or not, hobbies at home, type of exercise (light or intense, parent-accompanied), internet entertainment time, and nap time. The third part of the questionnaire was the standard sleep quality scale, the Pittsburgh Sleep Quality Index (PSQI).²⁰

Participants

Originally, a total of 3416 students completed a self-administered questionnaire via their mobile phones, computers or laptops. It took participants approximately 5 to 10 minutes to complete the questionnaire. To ensure the quality of the responses, 33 questionnaires were excluded from the analysis because of incorrect school information, 26 because their information was incomplete and another 50 because they took less than 3 minutes to complete the questionnaire. Finally, 3256 students were included in the study. All individuals agreed to provide their personal information and informed consent, and completed the questionnaires voluntarily and anonymously.

Measures

The PSQI scale is composed of 7 factors: subjective sleep quality, sleep time, sleep latency, sleep efficiency, sleep disturbance, sleeping drug use and daytime dysfunction. The total PSQI score is 0 to 21 points; the higher the score, the worse the sleep quality. In this study, a total PSQI score >7 was defined as poor sleep quality.⁹ **Light exercise** was defined as exercise during which people can talk or sing, including walking, jogging, Tai chi, and yoga;^{21,22} **intense exercise** meant people had to stop and catch their breath to speak during exercise, including playing ball games and running.²¹

Grade ranking. In many colleges in China, at the end of each semester, there is a comprehensive evaluation of each student's scores in various subjects, and the evaluation results are specific scores. By ranking the scores of students in the same grade and major from high to low, each student receives their ranking, which is the grade ranking. Through ranking, teachers and students can master students' overall learning situation and measure students' learning status.

Student cadre. A manager in a student council or student activity group.

Data Analysis

Statistical analysis was performed with IBM® SPSS statistical software version 24.0 (IBM Corporation, Armonk, NY, USA). First, to explore the severity distribution in students with good/poor sleep quality, we adopted a dichotomic classification with a cut score of 7 based on the data form to categorize students as having either good or poor sleep quality. Then, we used the independent-sample t-test to assess the relationship between continuous variables and the chi-square test to assess relations of categorical variables.

Univariate logistic regression was used to analyze the risk factors that may affect the sleep quality of college students and **multivariate logistic regression** was used to determine the association between different risk factors; odds ratio (OR) and 95% confidence intervals (CI) were estimated. When bilateral $P < .05$, this factor was considered to be independently correlated with poor sleep quality.

The binomial nonlinear regression method was used to determine the sleep efficiency and PSQI score, and the relationship between sleep efficiency and PSQI was obtained.

The study used the **bilateral P values**; values of $P < .05$ were considered statistically significant.

RESULTS

Demographic Characteristics, Course of Study and Life Status

As shown in Table 1, the percentage of college students with poor sleep quality was 15.97% in southern Anhui province during COVID-19. The majority of the students were female (67.4%), most were from urban areas (53.9%) and the mean (SD) age was 20.4 ± 1.8 years. The prevalence of poor sleep quality among medical and art students was significantly higher than among students who majored in sports and other subjects ($P < .01$). There was a statistically significant higher prevalence of poor sleep quality in individuals from single-parent families compared with individuals from 2-parent families ($P < .01$). The sleep quality of individuals with the grade ranking of 201 to 300 was poorer than in individuals in the 1 to 200 ($P = .02$) grade ranking.

Comparison of COVID-19 Knowledge and Studies Status of College Students in Home Quarantine During the Pandemic

Table 2 shows the lifestyle of college students during home quarantine. Knowledge of COVID-19 ($P < .01$), light exercise ($P < .01$) and parent-accompanied exercise ($P < .01$) was positively correlated with sleep quality; internet entertainment time ($P < .01$) and nap time ($P < .01$) were negatively correlated with sleep quality.

Sleep Quality Influence and Risks

Table 3 shows the results of univariate logistic regression analysis. There were statistically significant differences in gender, study major, single parent, domestic violence, grade ranking, COVID-19 knowledge, light exercise, parent-accompanied exercise, internet entertainment time and nap time. (all, $P < .05$). However, there were no statistically significant differences in age, BMI, parents' occupation(s), marital status, smoking status, student cadre, participation in interest groups at school, gated community residence, home hobbies or intense exercise ($P > .05$).

As presented in Table 4, the potential influence of sleep quality ($P < .05$) was included in the multivariate logistic regression analysis. After adjusting for the previously mentioned potential confounders, the results showed that college students with single-parent families (odds ratio [OR],

Table 1. Baseline Characteristics of College Students Stratified by Sleep Quality

Variables	Overall n = 3256	Sleep Quality		P value
		Good n = 2736	Poor n = 520	
Gender				.01
Male, n (%)	1060(32.6)	917(33.5)	143(27.5)	
Female, n (%)	2196(67.4)	1819(66.5)	377(72.5)	
Age (y), mean (SD)	20.4(1.8)	20.4(1.7)	20.4(2.0)	.32
BMI, mean (SD)	24.6(13.0)	24.6(13.3)	24.6(11.7)	.99
Residence				.99
Urban, n (%)	1754(53.9)	1474(53.9)	280(53.8)	
Country, n (%)	1502(46.1)	1262(46.1)	240(46.2)	
Major				<.01
Art, n (%)	172(5.3)	138(5.0)	34(6.5)	
Sport, n (%)	201(6.2)	176(6.4)	25(4.8)	
Medical, n (%)	1579(48.5)	1295(47.3)	284(54.6)	
Other, n (%)	1304(40.0)	1127(41.2)	177(34.0)	
Single parent				<.01
Yes, n (%)	288(8.8)	222(8.1)	66(12.7)	
No, n (%)	2968(91.2)	2514(91.9)	454(87.3)	
Parents' occupation(s)				.41
Medical staff, n (%)	51(1.6)	45(1.6)	6(1.2)	
Non-medical staff, n (%)	3205(98.4)	2691(98.4)	514(98.8)	
Marital status				.61
Married or in love, n (%)	779(23.9)	650(23.8)	129(24.8)	
Single, n (%)	2477(76.1)	2086(76.2)	391(75.2)	
Smoking status				.47
Smoker, n (%)	155(4.8)	127(4.6)	28(5.4)	
Non-smoker, n (%)	3101(95.2)	2609(95.4)	492(94.6)	
Domestic and social violence				<.01
Frequently (≥ 5 x/yr), n (%)	29(0.9)	16(0.6)	13(2.5)	
Occasionally (1-5 x/yr), n (%)	212(6.5)	144(5.3)	68(13.1)	
None, n (%)	3015(92.6)	2576(94.2)	439(84.4)	
Grade ranking				.02
1-100, n (%)	1586(48.7)	1352(49.4)	234(45.0)	
101-200, n (%)	670(20.6)	574(21.0)	96(18.5)	
201-300, n (%)	477(14.6)	383(14.0)	94(18.1)	
≥ 300 , n (%)	523(16.1)	427(15.6)	96(18.5)	
Student cadre				.78
Yes, n (%)	1245(38.2)	1049(38.3)	196(37.7)	
No, n (%)	2011(61.8)	1687(61.7)	324(62.3)	
Participation in interest groups at school				.46
≥ 3 projects, n (%)	257(7.9)	209(7.6)	48(9.2)	
1-2 projects, n (%)	1908(58.6)	1606(58.7)	302(58.1)	
None, n (%)	1091(33.5)	921(33.7)	170(32.7)	

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 2. Comparison of COVID-19 Knowledge and Study Status of College Students in Home Quarantine During the Pandemic

Variables	Overall (n = 3256)	Sleep Quality		P value
		Good (n =2736)	Poor (n =520)	
COVID-19 knowledge				<.01
Very familiar, n (%)	1262(38.8)	1060(38.7)	202(6.2)	
Familiar, n (%)	1565(48.1)	1338(48.9)	227(43.7)	
Not familiar, n (%)	429(13.2)	338(12.4)	91(17.5)	
Gated community				.55
Closed, n (%)	572(17.6)	477(17.4)	95(18.3)	
Partially closed, n (%)	2586(79.4)	2173(79.4)	413(79.4)	
Not closed, n (%)	98(3.0)	86(3.1)	12(2.3)	
Living with family				.09
Living with parents, n (%)	2981(91.6)	2507(91.6)	474(91.2)	
Living with relatives, n (%)	237(7.3)	202(7.4)	35(6.7)	
Living alone, n (%)	38(1.2)	27(1.0)	11(2.1)	
Hobbies at home				.44
≥3 hobbies, n (%)	183(5.6)	158(5.8)	25(4.8)	
1-2 hobbies, n (%)	1873(57.5)	1562(57.1)	311(59.8)	
None, n (%)	1200(36.9)	1016(37.1)	184(35.4)	
Light exercise				<.01
>1 hr/ n (%)	264(8.1)	242(8.8)	22(4.2)	
30 min-1 hr/day, n (%)	765(23.5)	661(24.2)	104(20.0)	
<30 min/day, n (%)	1627(50.0)	1361(49.7)	266(51.2)	
None, n (%)	600(18.4)	472(17.3)	128(24.6)	
Intense exercise				.18
>1 hr/day, n (%)	159(4.9)	138(5.0)	21(4.0)	
30 min-1 hr/day, n (%)	514(15.8)	445(16.3)	69(13.3)	
<30 min/day, n (%)	1331(40.9)	1117(40.8)	214(41.2)	
None, n (%)	1252(38.5)	1036(37.9)	216(41.5)	
Parents-accompanied exercise				<.01
>3 times/wk, n (%)	326(10.0)	297(9.1)	29(5.6)	
1-2 times/wk, n (%)	1308(40.2)	1113(40.7)	195(37.5)	
None, n (%)	1622(49.8)	1326(48.5)	296(56.9)	
Internet entertainment time				<.01
>6 hr/day, n (%)	1231(37.8)	996(36.4)	235(45.2)	
3-6 hr/day, n (%)	1340(41.2)	1157(42.3)	183(35.2)	
<3 hr/day, n (%)	685(21.0)	583(21.3)	102(19.6)	
Nap time				<.01
>4 hr/day, n (%)	141(4.3)	103(3.8)	38(7.3)	
2-4 hr/day, n (%)	273(8.4)	204(7.5)	69(13.3)	
<2 hr/day, n (%)	1362(41.8)	1166(42.6)	196(37.7)	
None, n (%)	1480(45.5)	1263(46.2)	217(41.7)	

Table 3. Univariate Regression Model of Variables Associated with Poor Sleep Quality

Variables	Univariate Regression Model		
	OR	95% CI	P Value
Gender			
Female	1.33	1.08-1.64	.007
Male	1	[Reference]	NA
Major			
Art	1.57	1.04-2.36	.030
Sports	0.90	0.58-1.42	.660
Medical	1.40	1.14-1.71	.001
Other	1	[Reference]	NA
Single parent			
Yes	1.65	1.23-2.21	.001
No	1	[Reference]	NA
Domestic and social violence			
Frequently ≥5 times/yr	4.77	2.28-9.98	<.001
Occasionally (1-5 times/yr)	2.77	2.04-3.76	<.001
None	1	[Reference]	NA
Grade ranking			
1-100 ranking	0.77	0.59-1.00	.050
101-200 ranking	0.74	0.55-1.01	.061
201-300 ranking	1.09	0.80-1.50	.587
≥300 ranking	1	[Reference]	NA
COVID-19 knowledge			
Very familiar	0.71	0.54-0.93	.014
Familiar	0.63	0.48-0.83	.001
Not familiar	1	[Reference]	NA
Light exercise			
>1 hour/day	0.34	0.21-0.54	<.001
30 min-1hour/day	0.58	0.44-0.77	<.001
<30 min/day	0.72	0.57-0.91	<.006
None	1	[Reference]	NA
Parent-accompanied exercise			
>3 times per week	0.44	0.29-0.65	<.001
1-2 times per week	0.79	0.64-0.96	.016
None	1	[Reference]	NA
Internet entertainment time			
>6 hr/day	1.35	1.05-1.74	.021
3-6 hr/ day	0.90	0.70-1.18	.450
<3 hr/day	1	[Reference]	NA
Nap time			
>4 hr/day	2.15	1.44-3.20	<.001
2-4 hr/day	1.97	1.45-2.68	<.001
<2 hr/day	0.98	0.98-0.79	.84
None	1	[Reference]	NA

Abbreviations: OR, odds ratio.

1.39; 95% CI, 1.02 to 1.89; $P = .036$) had poorer sleep quality than students with 2-parent families during the home quarantine period. College students who experienced domestic violence ≥ 5 times/year (OR, 3.68; 95% CI, 1.70 to 7.96; $P = .001$) had more than 3 times the risk for poor sleep quality compared with college students who had never experienced domestic violence. Of note, the more familiar the student was with COVID-19 (OR, 0.71; 95% CI: 0.53 to 0.96; $P = .024$), the better their sleep quality was. College students who engaged in more than 1 hour of light exercise/day (OR, 0.47; 95% CI, 0.28 to 0.78; $P = .004$) had better sleep quality during the home quarantine period. College students who engaged in parent-accompanied exercise 3 times/week (OR, 0.59; 95% CI, 0.38 to 0.90; $P = .014$) had better sleep quality during the home quarantine period. In addition, we found that napping for 2 to 4 hours/day (OR, 1.90; 95% CI, 1.25 to 2.90; $P = .003$) was significantly associated with poor sleep quality.

Sleep Efficiency and PSQI Score

Figure 1 shows a curve through data fitting. In this coordinate chart, sleep efficiency was on the vertical axis and PSQI score was on the horizontal axis. By fitting the data, it can be concluded that when the PSQI score is between 0 and 7, the curve of sleep efficiency is relatively gentle; with a PSQI score >7 , sleep efficiency showed a steep gradient. Thus, we used 7 as the cutoff between poor and good sleep quality.

DISCUSSION

In this study, more than 3000 college students from Anhui Province, China, reported their lifestyle and sleep quality during the home quarantine period. The percentage of college students with poor sleep quality was 15.97%, which was higher than that before the COVID-19 pandemic.²³ This may be because the social activities of college students and their friends could only be carried out on the internet due to home isolation policy put in place, which affected their mental health and thus their sleep quality.²²

Our study found that single-parent families are a risk factor for poor sleep quality, possibly because long-term quarantine at home made the absence of important family roles more obvious, thus causing students to have negative moods, leading to poor sleep quality. In addition, domestic violence is a risk factor for poor sleep quality, which is consistent with previous studies,^{24,25} as sleep quality in college students is influenced by the parent-child relationship. In our research, college students who exercised regularly with their parents tended to sleep better, which is another way of indicating that the sleep quality of college students is related to the parent-child relationship.²⁶ Our study, which found higher rates of poor sleep among medical students, is consistent with a study 2021 study from Nepal.²⁷ This may be because medical students are under more academic pressure or have more anxiety about the pandemic than students in other major fields of study.

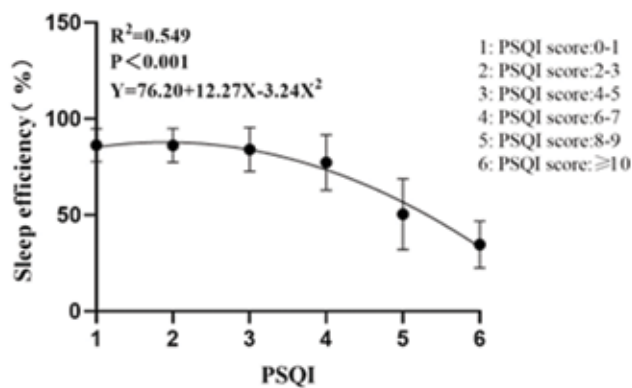
There is some evidence that napping improves academic performance²⁸ and endurance performance,²⁹ and moderate

Table 4. Multivariate Regression Model of Variables Associated with Poor Sleep Quality

Variables	Multivariate Regression Model		
	OR	95% CI	P value
Single parent			
Yes	1.39	1.02-1.89	.036
No	1	[Reference]	NA
Domestic and social violence			
Frequently ≥ 5 times/yr	3.68	1.70-7.96	.001
Occasional (1-5 times/yr)	2.36	1.72-3.24	<.001
None	1	[Reference]	NA
COVID-19 knowledge			
Very familiar	0.71	0.53-0.96	.024
Familiar	0.62	0.46-0.82	.001
Not familiar	1	[Reference]	NA
Light exercise			
>1 hr/day	0.47	0.28-0.78	.004
30 min-1hr/day	0.75	0.55-1.04	.085
<30 min/day	0.85	0.65-1.10	.20
None	1	[Reference]	NA
Parents-accompanied exercise			
>3 times/week	0.59	0.38-0.90	.014
1-2 times/week	0.95	0.76-1.18	.636
None	1	[Reference]	NA
Nap time			
>4 hr/day	1.90	1.25-2.90	.003
2-4 hours per day	1.94	1.41-2.67	<.001
<2 hours per day	1.07	0.86-1.33	.538
None	1	[Reference]	NA

Abbreviations: OR, odds ratio.

Figure 1. The relationship between sleep efficiency and PSQI score.



daytime napping improves sleep quality at night.³⁰ However, our study found that excessive napping is associated with poor sleep quality, which is consistent with research by Ye, et al.³¹ The flexible schedules of college students may permit more daytime napping during home quarantine, which affects nocturnal sleep quality, particularly in individuals who take long naps. Excessive daytime naps may deprive them of sleep at night and thus they require naps the next day to compensate. Due to the interaction between excessive daytime sleep and night sleep deprivation, the sleep quality of college students is affected.³²

The most important finding of our study was the effect of light exercise and parent-accompanied exercise on improving the sleep quality of college students. Many previous studies found that exercise improved sleep quality³³ and light exercise has a positive effect on mental health.³⁴ This is because exercise resulted in a significant increase in tendon blood flow³⁵ and elevated serum beta-endorphin concentrations, which can induce several psychological and physiological changes.³⁶ These data suggest that college students can improve their sleep quality by increasing exercise in challenging situations. Moreover, this is consistent with previous research that found that intense exercise had no significant impact on sleep quality.³⁴ Exercise evokes sympathetic nervous system activation,³⁷ but sympathetic overactivity caused by intense exercise may result in poor sleep quality.³⁸ So, we should encourage more college students to strengthen their daily exercise routine and control the intensity of their exercise.

Results of our analysis revealed that the COVID-19 pandemic has had a huge impact on individuals and societies. Our findings may provide useful and timely information for the development of new action plans for physical education and public health services. Specifically, our findings could help healthcare professionals, practitioners and educators understand the lifestyle and health status of Chinese college students, and provide effective forms of exercise to help them cope with pandemics or challenging extreme situations.

A randomized controlled design will be necessary in future trials in order to examine the effectiveness of at-home exercise programs in improving sleep quality.

Study Limitations

This study had several limitations. First, the participants were all college students from southern Anhui Province, China, and thus did not cover the whole country. Moreover, due to different challenging situations in different regions during COVID-19, the pandemic affected college students to different degrees, which affected the data results to some extent. Second, this study found that light exercise can improve sleep quality, but intense exercise has no significant relationship with sleep quality, the reasons for which have not been explored. Finally, this study is a cross-sectional study, which can only evaluate the correlation between factors and results and cannot speculate on the causal relationship.

CONCLUSION

The present study found that college students in single-parent families and college students who had experienced domestic violence were at a high risk for poor sleep quality during the COVID-19 pandemic in China. College students who were familiar with COVID-19 and who had light exercise or parent-accompanied exercise habits had better sleep quality. As of September 1, COVID-19 was still pandemic worldwide, so targeted sleep health interventions must be established to actively guide college students' healthy living habits. In addition, the sleep disorders and other health problems that may occur in special groups should be dealt with in advance; this should be the routine task of global disease prevention.

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