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ORIGINAL RESEARCH

Evaluation of Sleep Habits, Generalized Anxiety, Perceived Stress, and Research Outputs Among Postgraduate Research Students in Hong Kong During the Coronavirus (COVID-19) Pandemic

Shahnawaz Anwer [1,2]
Heng Li [2]
Maxwell Fordjour Antwi-Afari [3]
Mohammad Abu Shaphe [4]
Ahmad Alghadir [1]
Arnold YL Wong [5]

[1]Rehabilitation Research Chair, College of Applied Medical Science, King Saud University, Riyadh, Saudi Arabia; [2]Department of Building and Real Estate, Faculty of Construction and Environment, Hong Kong Polytechnic University, Kowloon, Hong Kong Special Administrative Region; [3]Department of Civil Engineering, College of Engineering and Physical Sciences, Aston University, Birmingham, B4 7ET, UK; [4]Department of Physical Therapy, College of Applied Medical Sciences, Jazan University, Jazan, Saudi Arabia; [5]Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Kowloon, Hong Kong Special Administrative Region

Purpose: The current study aimed to evaluate the impact of coronavirus (COVID-19) pandemic on sleep hygiene, anxiety levels, perceived stress, and research output among postgraduate research students in Hong Kong.

Methods: An online survey was developed and distributed to Hong Kong postgraduate research students. The sleep hygiene, anxiety levels, and perceived stress during the outbreak of COVID-19 were assessed. Questions about COVID-19's impact on research outputs were asked.

Results: A total of 108 (response rate, 72%) full-time postgraduate students (PhD, 64%; M Phil, 8%; and Masters, 28%) participated. Approximately 83% of students reported poor sleep hygiene. Similarly, nearly 76% of students reported mild to severe levels of self-perceived anxiety levels. Most of the respondents (89%) expressed a moderate level of perceived stress. Sleep hygiene scores were moderately associated with anxiety levels (r = 0.384, p < 0.01) and perceived stress scores (r = 0.423, p < 0.01). Perceived stress was strongly correlated with anxiety levels (r = 0.601, p < 0.01). A hierarchical regression analysis revealed a significant association between respondents' ethnicity (B = −0.923, p = 0.003), past medical history (such as hypertension, diabetes, and musculoskeletal disorders) (B = 1.112, p = 0.005), or poor sleep hygiene (B = 0.259, p = 0.000) and high levels of perceived stress. Additionally, prior medical history (such as hypertension, diabetes, and musculoskeletal disorders) (B = 1.957, p = 0.001) and poor sleep hygiene (B = 0.312, p = 0.000) were found to be strongly related to anxiety levels among postgraduate research students.

Conclusion: This is the first study that highlights poor sleep hygiene, moderate-to-severe levels of anxiety, and perceived stress during the COVID-19 pandemic in postgraduate research students in Hong Kong. These findings will help educators to prepare strategies to alleviate the stress and psychological problems in postgraduate students.

Keywords: coronavirus, COVID-19 pandemic, postgraduate students, research, anxiety, sleep hygiene, stress

Introduction

Coronavirus disease 2019 (COVID-19) has been declared as a pandemic and a public health emergency by the World Health Organization (WHO) on January 30, 2020.[1] Approximately, 223 countries and territories have been affected by the COVID-19 pandemic worldwide.[2] As of June 9, 2021, more than 173 million people have contracted the new coronavirus and over 3.7 million people died from COVID-19 globally.[2] To prevent the spread of the new coronavirus, ie, severe acute

Correspondence: Shahnawaz Anwer
Email Shahnawaz.anwer@connect.polyu.hk

respiratory syndrome (SARS-CoV-2), many countries have adopted multiple containment measures including a ban of mass gatherings, social distancing, closure of educational institutions, religious centers, community centers, amusement parks, and shopping malls.[3] Similarly, Hong Kong has also implemented these containment measures to prevent the spread of the virus and to flatten the curve.[4,5] Although Hong Kong has a population of approximately 7.5 million, it successfully kept the number of confirmed cases and death tolls to 11,873 and 210, respectively, as of June 9, 2021.[2] However, due to the suspension of academic activities, public parks, and fitness centers, the physical, mental, and social wellbeing of all levels of students may have been greatly impacted. In particular, postgraduate research students are not allowed to carry out their day-to-day research activities (eg, experiments), which may inevitably affect their research outputs.[6] While the COVID-19 pandemic has caused suspension of life globally, research students may be one of the most affected communities among others.[7] A recent survey on the impacts of the COVID-19 outbreak on 424 universities and other higher education institutions from 111 countries and territories found that about 80% of higher education institutions reported their research activities being negatively impacted by the COVID-19 pandemic.[8] The most commonly impacted activities were cancellation of foreign travels (83% of participating institutions), cancellation of research conferences (81% of participating institutions), and missing the proposed completion deadline of research projects (52% of the participating institutions). Since the academic journey of postgraduate research students cannot be stopped due to the COVID-19 pandemic,[9] they are at risk of developing a poor sleep habit (eg, wake up late and stay up late; consumption of alcohol, tobacco, or caffeine at bedtime; or playing video games; use of internet or watching television at bedtime) and worrying about their academic performance in an adverse condition.

Sleep is important for physical and mental health, as well as cognitive function.[10,11] Poor sleep can negatively impact academic performance,[12] while sufficient sleep can boost immunity and help fight against stress and other infections.[13] Poor sleep quality is known to be associated with behavioral and environmental factors (such as poor sleep habits, also known as sleep hygiene).[14] Sleep hygiene refers to habits, daily practices, and environmental factors (eg, cold, hot, or bright bedrooms) that are vital for improving sleep quality at night.[15] Although the impacts

of sleep hygiene on sleep quality in university students have not been examined, sleep hygiene is one of the most important variables that needs to be checked among individuals with poor sleep quality.[16] While sleep hygiene behaviors can potentially affect sleep quality, poor sleep hygiene is detrimental to sleep.[17] Many behaviors and environmental factors (eg, avoiding caffeine, alcohol, and nicotine at bedtime; avoiding daytime naps; adherence to regular sleep and wake time; keeping a bedroom neat and clean; and avoiding television watching or smartphone usage at bedtime) are considered as proper sleep hygiene that may promote the quality of sleep.[17]

Since sleep hygiene is one of the important factors affecting sleep quality and quantity, some studies have examined sleep hygiene behaviors among college and university students.[18–20] Poor sleep hygiene not only is associated with poor academic performance[21–23] but also in university students who had a history of anxiety,[24,25] and stress.[26] While some studies identified generalized anxiety as one of the risk factors for poor sleep hygiene among university students and the general population,[27,28] others suggested a bidirectional relationship between generalized anxiety and depression and poor sleep hygiene among the general population.[29,30] Furthermore, significant associations were noted between generalized anxiety and sleep quality or excessive daytime sleepiness in university students.[31]

Postgraduate research students are known to experience multiple sources of anxiety or perceived stress (eg, deadlines to complete various projects, publication demands, course work requirements, and thesis submissions).[32,33] Additionally, increased exposure to television has been observed to have a detrimental effect on mental health during the pandemic.[34] However, there is limited relevant research regarding sleep hygiene, anxiety levels, and perceived stress among postgraduate research students during the COVID-19 pandemic. Additionally, the fear of getting infected with COVID-19 may increase stress and anxiety. Furthermore, COVID-19 may lead to a lack of daily routine (eg, going to campus to conduct experiments) that may cause research students to stay up late at night to play games or to study, which may affect sleep hygiene and overall research output of postgraduate research students. Therefore, this study aimed to evaluate the impact of the COVID-19 pandemic on sleep habits, anxiety levels, perceived stress, and research outcomes among postgraduate students studying in Hong Kong. The findings may help design effective prevention or

management strategies to minimize the negative effects of COVID-19 on postgraduate research students.

Materials and Methods

An online self-administered questionnaire was developed using the validated sleep hygiene index (SHI),[35] generalized anxiety disorder (GAD-7) index,[36] and perceived stress scale (PSS-10).[37] Full-time postgraduate research students including PhD, MPhil, and masters aged 18 years or older were invited to participate in the survey. This research project was approved by the Human Subjects Ethics Sub-committee of The Hong Kong Polytechnic University (Reference number: HSEARS20200616004). The online questionnaire was divided into five screen pages: (1) 11 questions related to socio-demographics; (2) 13 questions related to sleep hygiene during the pandemic (a component of SHI); (3) 7 questions related to anxiety levels during the pandemic (a component of GAD index); (4) 10 questions related to self-perceived stress during the pandemic (a component of PSS-10 scale); and (5) 6 questions related to the impacts of COVID-19 on research outputs. Additionally, participants were asked to report their major concerns during the COVID-19 pandemic. An English questionnaire was used. The survey was developed using the Typeform© survey platform, which has been used in similar previous studies.[38,39] This survey took approximately 15 minutes to complete. A browser cookie was used to prevent respondents from repeating the survey in the same browser. No monetary incentives were offered to participants, but there was link to a website that offer COVID-19 information (eg, the World Health Organization website) and telephone numbers for seeking assistance, support, or more information. An invitation email with the hyperlink to the online survey was sent to the research offices of 8 government-aided universities in Hong Kong. They were requested to forward the email to all their postgraduate research students to invite their participation. The participant would automatically give their implied consent to participate if they accepted the invitation and submitted their questionnaire. Participation was voluntary and participants could quit at any time even after they had started (Figure 1). This study was carried out in compliance with the Helsinki Declaration's guidelines.

The data was collected between 18th June 2020 and 18th August 2020, during which the Hong Kong government declared a state of health emergency for COVID-19. In particular, the Hong Kong government implemented a number of containment measures, including a prohibition on group gatherings, social segregation, as well as the closure of educational institutions, religious centers, community centers, amusement parks, and shopping malls. Additionally, the government offered free COVID-19 testing to the general public via a variety of channels. Asymptomatic individuals who were suspected to be at a higher risk of exposure would obtain free test kits at designated public clinics or other distribution points. Individuals required to take mandatory tests should visit community testing centers for free testing. Additionally, these centers offered self-pay services to those who required test reports for personal use. As a result, the majority of students were confined to their dormitory or home at the time of our data collection of this research and were not permitted to visit the university campus for their research activities.

Descriptions of SHI, GAD-7, and PSS-10 Questionnaires
SHI

The SHI is a 13-item questionnaire, which was developed to evaluate sleep hygiene during a routine day-to-day life.[35] The International Classification of Sleep Disorders (ICSD-2; American Academy of Sleep Medicine) has classified sleep hygiene behaviors into five categories: (1) improper sleep wake-up cycle (eg, napping, irregular bed and wake times); (2) the use of sleep affecting substances (eg, caffeine, nicotine, and alcohol); (3) behaviors that boost arousal at bedtime (eg, engaging in emotional or exciting activities); (4) use of the bedroom other than sleep (eg, reading, watching television); and (5) unable to sustain a pleasant sleeping environment (eg, distressing temperature or mattress). Individuals were asked to indicate if they engaged in specific sleep hygiene behaviors.[40] A 5-point Likert scale in which '0' indicating "never" and '4' indicating 'always' was used for the scoring. The final SHI score (ranging between 0 and 52) was calculated by summing all item scores. A higher SHI score indicates poorer sleep hygiene behavior. The SHI has shown acceptable reliability (Cronbach's α = 0.66; McDonald's Omega = 0.76) and validity in different populations (including university students).[35,41]

GAD-7

The GAD-7 is a 7-item questionnaire designed to assess the magnitude of generalized anxiety symptoms as described in the Diagnostic and Statistical Manual of Mental Disorders-IV.[35] It is graded on a 5-point Likert scale, where '0' indicates "not at all" and '4' implies
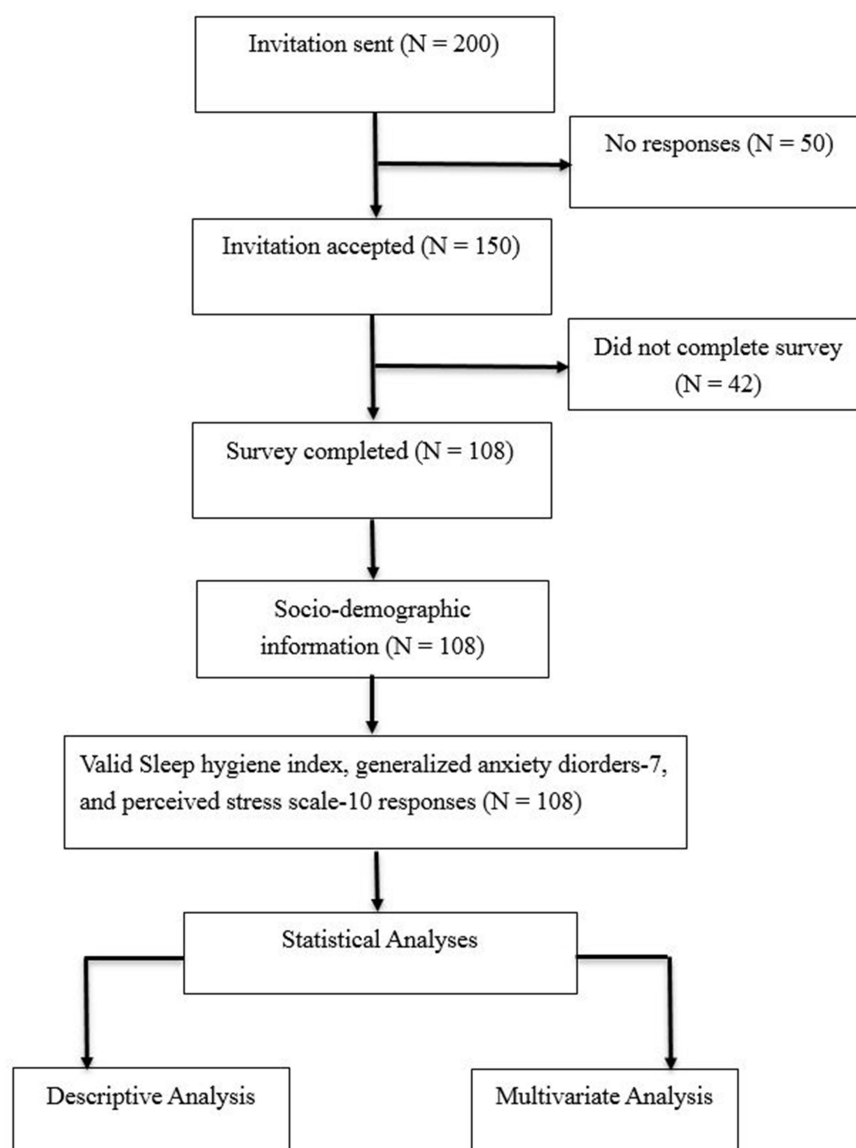
Figure 1 Flow chart of survey process.

'nearly every day'. The final GAD-7 score was calculated by adding all items (a maximum of 28). The GAD-7 has adequate reliability (Cronbach's alpha = 0.83) and validity in multiple populations including university students.[42,43]

PSS-10

The PSS-10 is a 10-item questionnaire designed to evaluate the levels of self-perceived stress.[36] Each item is graded on a 5-point Likert scale indicating "never" (0 scores) and "very often" (4 points). PSS score ranges from 0 to 40. The final PSS score was calculated by reversing the responses of positively stated questions 4, 5, 7, and 8 (eg, 0 = 4, 1 = 3, 2 = 2, 3 = 1 and 4 = 0) and then adding the scores of all items.[36] Greater scores mean higher levels of stress.

Previous studies found an adequate internal consistency (McDonald's Omega = 0.68 to 0.80) of PSS-10.[44,45]

Data Analysis

Data were analyzed using the statistical package for social sciences (SPSS, Windows version 22, IBM, USA). Pearson correlations coefficients were used to evaluate the bivariate correlations among SHI, anxiety levels, and PSS scores during the COVID-19 pandemic. Separate hierarchical regression models were used to identify independent determinants for anxiety levels and perceived stress scores. In these models, age, sex, marital status, and ethnicity were entered at the first regression step. Accommodation, level of education, and field of research were then entered as the second step in the anxiety

levels and perceived stress models. Past medical history, country of stay during the outbreak of COVID 19, and sleep hygiene scores were subsequently entered at the third step.[46] The strengths of associations were estimated by the beta coefficient. Additionally, effect sizes of regression analyses (ie, Cohen's f^2) were calculated using an R^2 value to identify clinically significant associated factors.[47] Twenty-four (16%) respondents were excluded because their responses had missing data in any variable. An online sample size calculator was used to estimate sample size (https://www.danielsoper.com/statcalc/default.aspx), which revealed that 105 individuals were required to detect a medium effect size ($f^2 = 0.17$). This was calculated based on a linear regression model with 10 independent variables under the assumption of 0.80 statistical power and an alpha level of 0.05. Data were considered statistically significant if $p < 0.05$.

Results
Socio-Demographics

One-hundred-eight respondents completed the survey (response rate, 72%). Table 1 details the respondents' socio-demographic data. Nearly two-thirds (n = 68, 63%) of the respondents were males. More than half (n = 59, 55%) of the respondents were unmarried. Approximately one-third (n = 39, 36%) of the respondents were living in a rented room. The respondents were mainly Indians (n = 37, 34%), Chinese/Hongkongers (n = 30, 28%), and African natives (n = 28, 26%). More than 66% of the respondents had no past medical history. Approximately 10% of the respondents reported a history of systemic illness (eg, high blood pressure, diabetes mellitus, etc.). Nearly one-third of the respondents reported that they have stayed in Hong Kong during the outbreak of COVID-19 pandemic. Majority of the respondents were currently studying PhD students (>50%). They were studied in the allied health (33%), medical (14%) or social science (12%), and engineering (30%) fields.

Sleep Hygiene, Generalized Anxiety, and Perceived Stress Scores During the COVID-19 Pandemic

Sleep habits, perceived anxiety, and perceived stress of postgraduate research students were high during the COVID-19 pandemic (Table 2). The SHI, GAD-7, and PSS-10 scores were 23.1 (SD, 7.3), 9.2 (SD, 6.2), and 21.3 (SD, 4.3),

Table 1 Demographics of Respondents

Variables (N = 108)	Frequency (%)
Age (Years)	
Mean (Standard deviation)	30.6 (4.8)
≤ 25	20 (18.5)
26–30	46 (42.6)
31–35	24 (22.2)
≥ 36	18 (16.7)
Gender	
Male	68 (63)
Female	40 (37)
Other	0 (0)
Marital status	
Unmarried	59 (54.6)
Married	49 (45.4)
Other	0 (0)
Ethnicity	
Indian	37 (34.3)
Chinese/Hongkongers	30 (27.7)
African	28 (25.9)
Arab	8 (7.4)
Others	5 (4.6)
Level of pursuing education	
PhD	69 (63.9)
M. Phil	9 (8.3)
Masters	30 (27.8)
Fields of research	
Engineering	32 (29.6)
Medical	15 (13.9)
Allied Health	36 (33.3)
Social Sciences	13 (12.0)
Others	12 (11.1)
Type of accommodation	
Rented room	39 (36.1)
Student hostel	27 (25.0)
Self-owned flat	23 (21.3)
Rented family flat	19 (17.6)
Others	1 (0.9)
Past medical history	
None	79 (73.1)
Systemic disease (eg, Hypertension, Diabetes Mellitus)	13 (12.0)
Musculoskeletal disorders (eg, low back pain, neck pain, knee pain)	7 (6.5)
Depression or Stress	9 (8.3)
Where did you stay during the outbreak of COVID 19 pandemic?	
Hong Kong	35 (32.4)
Asia (other than Hong Kong, mainland China, Taiwan, or India)	23 (21.3)
India	16 (14.8)
Arab countries (Saudi Arabia and UAE)	15 (13.9)
African countries (Nigeria and Ghana)	9 (8.3)
Others	10 (9.3)

Table 2 Associations Among Sleep Habits, Generalized Anxiety, and Perceived Stress Scores During the Coronavirus (COVID-19) Pandemic

| (N = 108)	Mean	SD	Range	Pearson Correlations	
			Min – Max	GAD-7	PSS-10
SHI (0–52)	23.1	7.3	6–41	0.384*	0.423*
GAD-7 (0–28)	9.2	6.2	0–21	———	———-
PSS-10 (0–40)	21.4	4.3	9–36	0.601*	———-

Notes: Data are mean (standard deviation); *Correlation is significant at the 0.01 level (2-tailed); SHI = Sleep Hygiene Index; GAD = Generalized Anxiety Disorders-7 scale; PSS-10 = Perceived stress scale-10.

respectively during the COVID pandemic. There were significant correlations among sleep hygiene, anxiety, and stress during the COVID-19 pandemic (Table 2). Percentage of poor sleep hygiene score was slightly higher in females compared to males (Figure 2). However, there were no significant differences in SHI scores between genders ($p > 0.05$). While the percentage of moderate levels of generalized anxiety was slightly higher in males than female students, more female students had a severe level of generalized anxiety than their male counterparts (Figure 3). However, there was no statistically significant difference between males and females ($p > 0.05$). Likewise, the percentage of moderate level of perceived stress was higher in males compared to females, although the severe level of perceived stress was equally distributed in both male and female students (Figure 4). However, these differences were statistically insignificant ($p > 0.05$).

Factors Affecting Generalized Anxiety and Perceived Stress During the COVID Pandemic

Table 3 summarizes the results of the hierarchical regression analyses regarding the determinants of anxiety levels and perceived stress scores. The determinants explained 29.0% of the variance in the anxiety levels model ($R^2 = 0.288$ (adjusted $R^2 = 0.215$, $F (10, 107) = 3.929$, $p = 0.000$)) and 35% of the variance in the perceived stress model ($R^2 = 0.346$ (adjusted $R^2 = 0.279$, $F (10, 107) = 5.136$, $p = 0.000$)). When individual determinants of anxiety levels were examined, prior medical history ($B = 1.97$, $p = 0.001$) and poor sleep hygiene
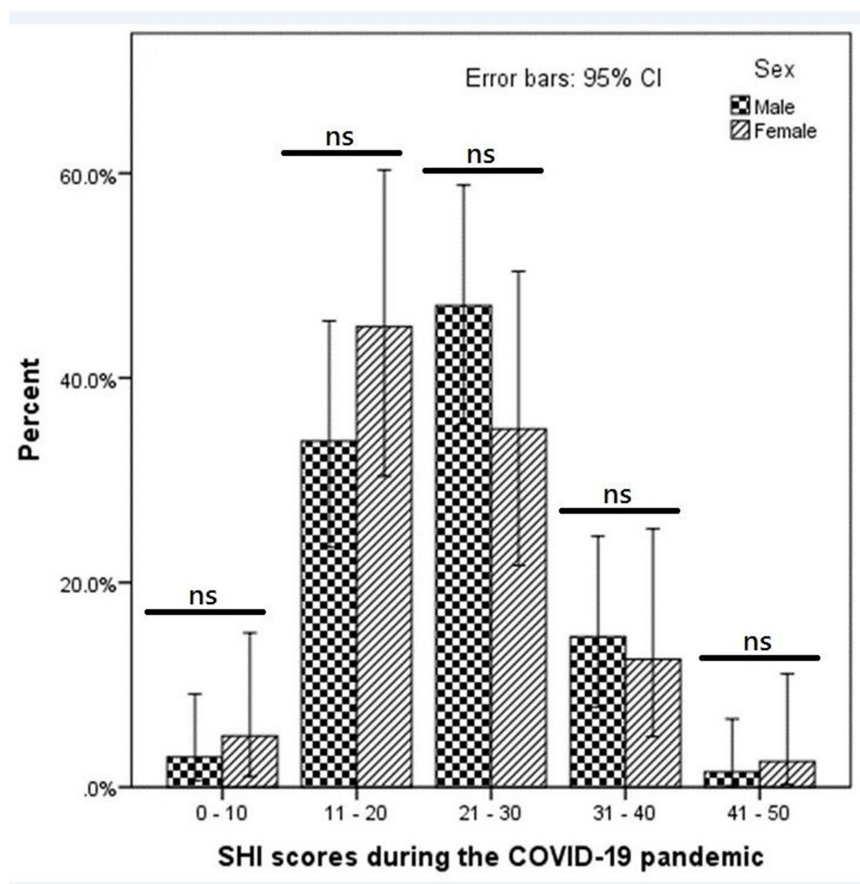
Figure 2 Percentage of poor sleep hygiene scores in males and females during the COVID-19 pandemic.
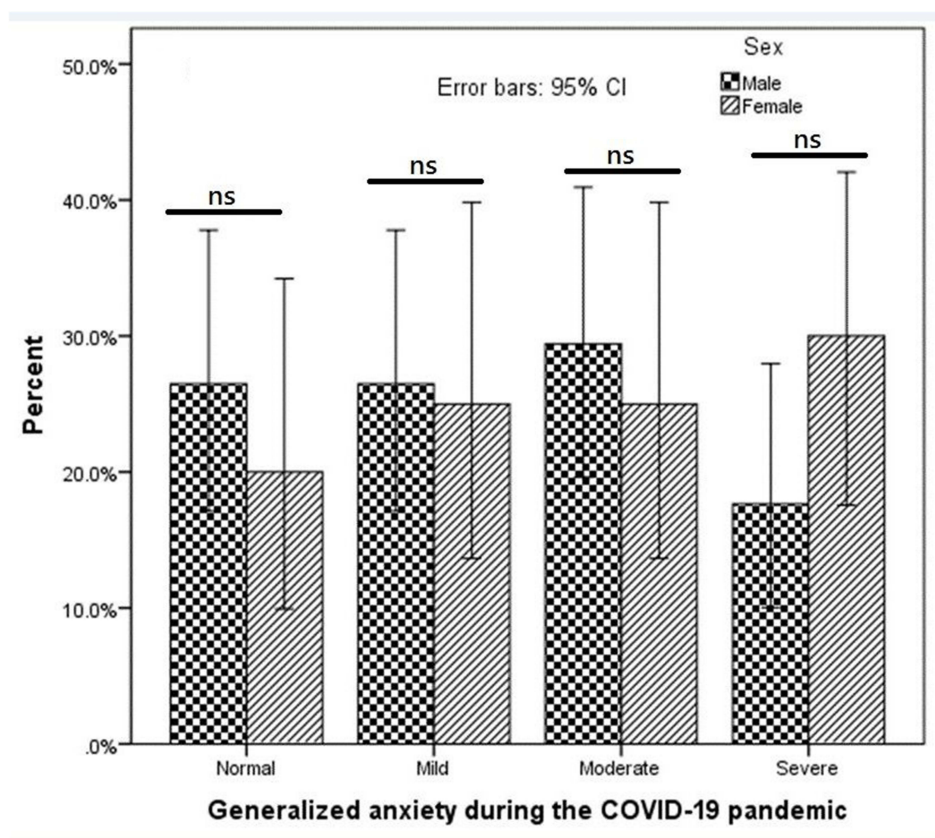
Figure 3 Percentage of anxiety levels in males and females during the COVID-19 pandemic.

(B = 0.312, p = 0.000) were significantly associated with an elevated level of anxiety scores. Likewise, ethnicity (B = −0.923, p = 0.003), past medical history (B = 1.112, p = 0.005), and poor sleep hygiene (B = 0.259, p = 0.000) were significantly associated with the level of perceived stress.

Impact of COVID-19 on Research Outcomes

Table 4 details the impacts of the COVID-19 pandemic on the research-related outputs. More than one-third of the respondents could hardly concentrate on their research work (eg, writing manuscripts, reading articles, etc.) during the COVID-19 pandemic. More than two-thirds of the respondents reported that they were not able to conduct their research experiments during the COVID-19 pandemic. While 36% of the respondents anticipated that they could resume normal research activities after 0–3 or 3–6 months, 19% of respondents thought it might take up to nine months to return to normal. Regarding the research experiments, one-third of the respondents made little change in their experiment(s) during the outbreak, one-fifth of the respondents made some-to-great changes. One-

fourth of the participants slightly changed their research topic due to the pandemic, but nearly half of the respondents made little to some modifications in the methods of data collection during the COVID-19 pandemic.

Table 5 illustrates the major concerns of postgraduate research students during the COVID-19 pandemic. The top six concerns of our respondents were: (1) lack of participants for research experiments; (2) fear of exposure to the novel coronavirus from research participants; (3) community transmission; (4) cancellation of international travels that might affect their attachment program; (5) unable to meet the supervisors frequently; and (6) unable to attend any scientific conferences.

Discussion

This study aimed to evaluate the impacts of the COVID-19 pandemic on sleep hygiene, anxiety levels, perceived stress, and research outcomes among postgraduate research students. Our findings revealed that postgraduate research students had poor sleep habits and increased generalized anxiety and self-perceived stress during the COVID-19 pandemic. The current study discovered an
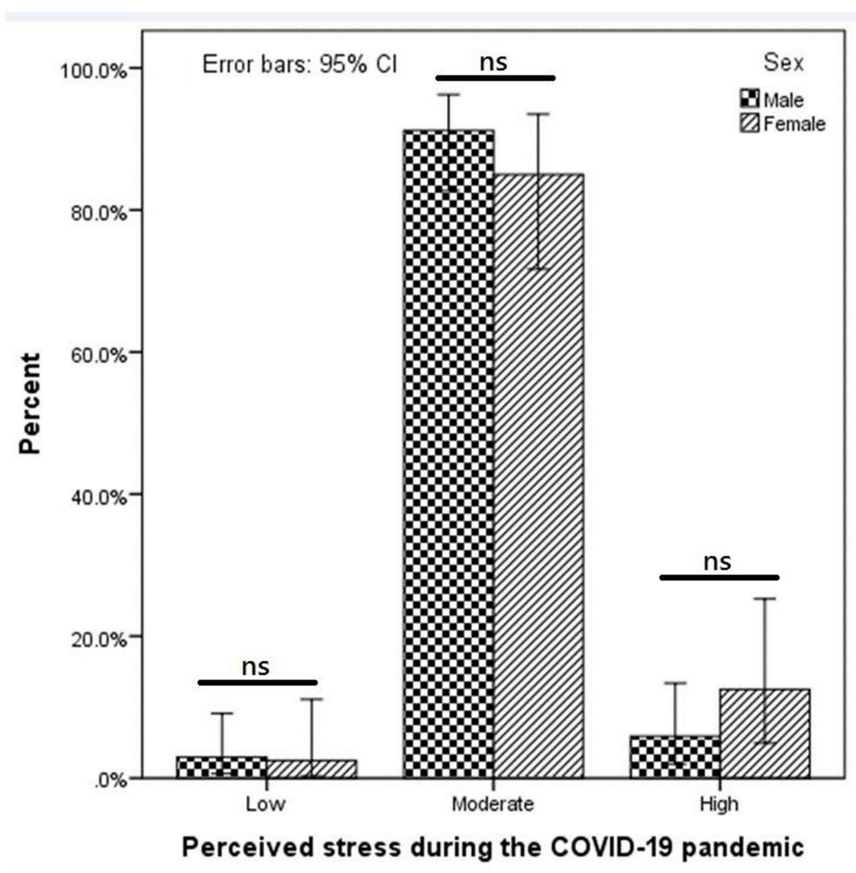
Figure 4 Percentage of perceived stress in males and females during the COVID-19 pandemic.

association between poor sleep hygiene, generalized anxiety, and perceived stress among postgraduate research university students during COVID-19. Various factors such as ethnicity, medical history (eg, systemic disease, musculoskeletal disorders, depression or stress), and poor sleep hygiene were associated with generalized anxiety and perceived stress during the COVID-19 pandemic in postgraduate research students. As hypothesized, COVID-19 pandemic also severely affected students' research work (such as difficulty in conducting research experiments and keeping pace or focus on their research), which caused a lot of concerns to postgraduate research students.

Impacts of COVID-19 on Sleep Hygiene

Our respondents reported poor sleep habits during the outbreak of COVID-19 pandemic, which concurred with research examining the impact of COVID-19 on sleep habits of medical professionals (a higher percentage of poor sleep score has been increased during the COVID-19 pandemic).[48] Similarly, recent studies have found

a significantly higher percentage of the general population had poor sleep hygiene during the COVID-19 pandemic.[49–52] Another study reported poor sleep hygiene scores among African university students prior to the COVID 19 pandemic.[53] The factors that contribute to poor sleep hygiene in postgraduate research students may be complex (eg, family issues, loneliness etc).[54] As a result, future research should focus on the factors of poor sleep hygiene among postgraduate students.

Impacts of COVID-19 on Generalized Anxiety and Perceived Stress

Previous studies have reported heightened levels of anxiety[49,55–57] and perceived stress[58–61] among the general population during the epidemic (severe acute respiratory syndrome and Covid-19). Wang et al[62] indicated increased anxiety and stress among college students during the COVID-19 pandemic. Similarly, studies in both developed and developing countries showed that undergraduate or postgraduate students had an increased level of anxiety, depression, or stress during the outbreak of COVID-19 pandemic.[63–65] Up to 48% of them

Table 3 Hierarchical Regression Predicting Generalized Anxiety and Perceived Stress During the COVID-19 Pandemic Among Postgraduate Research Students

Variables (N = 108)	Generalized Anxiety				Perceived Stress			
	R^2	B	p	f^2	R^2	B	p	f^2
Block 1								
Age	0.040	0.278	0.099	0.042	0.057	0.003	0.979	0.060
Sex		2.065	0.132			0.941	0.318	
Marital status		−2.086	0.161			−0.763	0.455	
Ethnicity		−0.092	0.846			−0.648	0.051	
Block 2								
Age	0.047	0.249	0.165	0.049	0.075	−0.017	0.890	0.081
Sex		2.131	0.148			0.750	0.455	
Marital status		−1.952	0.202			−0.611	0.559	
Ethnicity		−0.121	0.805			−0.674	0.046	
Accommodation		0.380	0.550			0.429	0.325	
Level of education		0.509	0.546			0.135	0.816	
Field of research		0.045	0.928			0.326	0.342	
Block 3								
Age	0.288	0.218	0.165	0.405	0.588	−0.037	0.722	1.427
Sex		1.937	0.136			0.655	0.448	
Marital status		−0.419	0.760			0.556	0.542	
Ethnicity		−0.417	0.357			−0.923	0.003*	
Accommodation		0.729	0.202			0.720	0.060	
Level of education		0.387	0.609			0.066	0.895	
Field of research		−0.251	0.573			0.143	0.630	
Past medical history		1.957	0.001*			1.112	0.005*	
Country of stay during the outbreak of COVID 19		0.268	0.442			0.279	0.231	
Sleep Hygiene		0.312	0.000*			0.259	0.000*	

Notes: *p<0.05; B = Beta; Effect size (f^2) = 0.02 (small), 0.15 (medium), 0.35 (large).

had severe levels of anxiety, depression, or stress.[62–65] Up to 50% of the adults in the UK experienced increased anxiety, depression, or stress due to fear of contracting the virus.[51] Particularly, health anxiety, which commonly occurs after the outbreak of any pandemic such as COVID-19.[66] Consequently, people may show unique behaviors such as social withdrawal, excessive hand washing, apprehensive purchasing, and consumption of resources including medications, protective masks, and hand sanitizers.[67] Teaching and research-related activities have been severely affected due to locked down and social distancing norms during the COVID-19 pandemic.[63] Additionally, most research conferences and attachment programs have been postponed or cancelled to minimize the risk of spreading COVID-19 pandemic.[8] All these factors may cause increased anxiety levels among postgraduate research students during the COVID-19 pandemic. Furthermore, uncertainty regarding academic and research progression could be a stressor for postgraduate students.[68]

People with higher levels of education were more anxious, depressed, and stressed during the COVID-19 pandemic. Recent studies have found that anxiety and depression levels are related to levels of education during the COVID-19 pandemic.[69,70] One Chinese study found that higher rates of mental illness among people with a higher level of education might be attributed to their higher self-awareness of their health.[71] Insufficient understanding of COVID-19, the high fatality rate of infected patients, and worries about its spread are good reasons to feel stressed.[72,73] Additionally, a low level of physical activity during the lockdown due to COVID-19 can cause more anxiety and stress.[74] Furthermore, reduced physical activity secondary to social distancing and lockdown may increase the risk of mental health.[75]

While past medical history (eg, systemic disease, depression, or stress) and poor sleep hygiene were significantly associated with increased generalized anxiety disorders, the ethnic origin, past medical history, and poor sleep hygiene

Table 4 Impacts of the Coronavirus (COVID-19) Pandemic on the Research-Related Outputs

Research Related Questions (N = 108)	Frequency (%)
Are you able to concentrate on your research activities (eg, writing manuscript, reading articles, etc.) during the COVID-19 pandemic?	
No	21 (19.4)
Minimal	24 (22.2)
To some extent	39 (36.1)
To a great extent	24 (22.2)
Are you able to conduct your experiments during the COVID-19 pandemic?	
No	51 (47.2)
Minimal	29 (26.9)
To some extent	21 (19.4)
To a great extent	7 (6.5)
After how long you think that you will be able to perform your research activities as normal as before COVID-19?	
0–3 months	39 (36.1)
3–6 months	39 (36.1)
6–9 months	21 (19.4)
> one year	9 (8.3)
Have you changed your research experiment(s) (eg, change to observational) due to COVID-19 pandemic?	
No	47 (43.5)
Little extent	37 (34.3)
Some extent	17 (15.7)
Great extent	7 (6.5)
Have you changed your research topic due to the COVID-19 pandemic?	
No	76 (70.4)
Little extent	20 (18.5)
Some extent	8 (7.4)
Complete changed	4 (3.7)
Have you modified your ways of data collection due to the COVID-19 pandemic?	
No	44 (40.7)
Little extent	27 (25.0)
Some extent	26 (24.1)
Great extent	11 (10.2)

were significantly related to increased perceived stress among postgraduate research students. A recent review revealed that patients with a history of anxiety demonstrated increased generalized anxiety disorders.[66] A recent study from Australia suggests that individuals with a history of mental health problems (eg, anxiety or stress) showed higher anxiety or stress compared to those who do not have a history of mental illness.[76] Since we did not collect the nature, severity, and type of stress or anxiety, it was difficult to evaluate whether these students had higher levels of anxiety or stress before the COVID-19 pandemic, or whether stress or anxiety increased due to COVID-19 pandemic as a result of social distancing, reduced family support, or fear of getting infected.[77] More recently, Manzar et al[78] have discovered a link between insufficient sleep hygiene habits and anxiety levels among university students. In contrast to current findings, a past study conducted in Malaysia found no significant correlation between ethnicity and anxiety, depression, or stress in university students.[79]

Similar to current findings, previous studies have reported no association between gender of students and anxiety or stress.[79–82] In contrast, other studies have suggested an association between some socio-demographic variables (including age and gender) and levels of anxiety.[55,83] Similarly, female students in Egyptian universities were prone to develop anxiety and less likely to suffer stress than their male counterparts.[84]

Impacts of COVID-19 Pandemic on Research Outputs of Postgraduate Research Students

Findings of our study revealed negative impacts of COVID-19 on the research outputs. Likewise, previous studies found a few impacts of COVID-19 on academic activities including difficulty in concentrating, lack of an interactive learning environment, and lack of motivation among undergraduate or graduate students.[85–87] The present study indicates that fear of getting infected with coronavirus was one of the major concerns of postgraduate research students during the COVID-19 pandemic. Likewise, previous studies in college/university students indicated that most of their respondents were worried they might get infected with COVID-19 disease.[62,88] They also indicated that COVID-19 pandemic affected their daily academic routine.[88] Additionally, travel and social restrictions during the pandemic significantly affected scientific research globally.[89]

Associations Between Poor Sleep Habit and Perceived Stress or Generalized Anxiety

This study found the positive correlations between poor sleep habit and perceived stress or generalized anxiety among

Table 5 Major Concerns of Postgraduate Research Students During the Coronavirus (COVID-19) Pandemic

Questions Related to Major Concerns (N = 108)	*Frequency (%)
Lack of participants for research experiments	47 (43.5)
Fear of exposing to the novel coronavirus from the participants	45 (41.7)
Lack of required equipment supply due to COVID-19	15 (13.9)
Increase research cost	15 (13.9)
Increase risk of contracting the virus during travel for data collection (eg, Community transmission)	38 (35.2)
Lack of resources for the thesis writing (eg, Library, internet, printing)	24 (22.2)
Unable to meet the deadlines of thesis submission	25 (23.1)
Running out of the funding support	15 (13.9)
Unable to meet the supervisors frequently	31 (28.7)
Unable to complete the required course work as planned	21 (19.4)
Unable to attend any scientific conferences	30 (27.8)
International travels are cancelled affecting attachment program	34 (31.5)

Note: *Multiple responses.

postgraduate research students in Hong Kong. While no study has investigated the associations between sleep habits and perceived stress or anxiety levels among postgraduate research students during the COVID-19 pandemic, a few past studies published before the COVID-19 pandemic found a significant association between poor sleep habits and poor mental health among college students.[90–92] For instance, a previous cross-sectional survey discovered that sleep-related problems including daytime sleeping and impaired sleep quality was associated with an increased risk of common mental disorders among college students.[90] Another study found that college students who had sleep disturbances had a higher anxiety symptom and a greater loss of cognitive and physical function than students who did not have sleep disturbances.[91] Similarly, Zhang et al[92] discovered a link between poor sleep quality and an elevated incidence of anxiety and depression in collegiate nursing students. They also discovered that perceived stress acts as a mediator between sleep quality and anxiety.[92] As a result, effective interventions are required to improve sleep hygiene behavior and mental health in postgraduate research students.

Strength and Limitations

This study had several strengths. First, this is the only study which captured the perception of sleep hygiene, generalized anxiety, and perceived stress during the COVID-19 pandemic among postgraduate research students. Second, the current study used standardized questionnaires (eg, SHI, GAD-7, and PSS-10) to assess sleep hygiene, generalized anxiety, and perceived stress in postgraduate research students. Finally, the impacts of COVID-19 on research-related works and major concerns

of postgraduate research students during the COVID-19 pandemic were highlighted.

Nonetheless, there are several limitations that should be acknowledged. First, this study failed to identify socio-demographic predictors of sleep hygiene, generalized anxiety, and perceived stress due to the small sample size. Second, since the current study was designed as a cross-sectional questionnaire-based survey, it could not establish a causal relationship. Third, this study adopted convenience sampling via an online platform, which might introduce a selection bias. Fourth, as the current study relied on self-reported data, it might be affected by participants' interpretations of the question items or their proclivity to report their emotions in particular ways. Finally, the participants of this study were all postgraduate research students studying at Hong Kong universities, which may limit the generalizability of this study to students studying in other countries.

Implications

Given the high prevalence of stress and anxiety, as well as poor sleep behavior among postgraduate research students during the pandemic, universities should take imminent actions to identify students at risk of mental health issues, and provide proper education to lower the risk of mental health and sleep-related problems among postgraduate students. Specifically, universities may reach out to postgraduate students by emails or through academic supervisors to identify students who need imminent financial or emotional supports. Teachers or academic supervisors should also pay more attention to students with known depression and/or other psychological problems and

provide appropriate assistance, if necessary. However, if teachers/supervisors notice that a student's psychological problems are severe, a prompt referral to university counseling services or health services is warranted to ensure that the student can receive timely professional consultations and treatments. In addition to identifying high risk cases, regular online webinars/workshops on mental health management and sleep hygiene should be organized to empower postgraduate students in managing their psychological distress and sleep problems during the pandemic. New online promotion (such as games, competitions, and plays) and educational activities (eg, videos and articles) can be launched to engage students, increase their awareness of these issues, and provide them with proper coping methods. These approaches together with adequate counseling services for postgraduate students during and after the COVID-19 outbreak can help students manage their stress and develop effective coping strategies. Furthermore, future research is warranted to evaluate the long-term impacts of COVID-19 on anxiety, stress, sleep, and academic performance of postgraduate students so that universities can better prepare for similar pandemics in the future.

Conclusion

Postgraduate research students had poor sleep hygiene, moderate-to-severe anxiety levels, and perceived stress during the COVID-19 pandemic in Hong Kong. The sleep hygiene behaviors, generalized anxiety, and perceived stress were high during the COVID-19 pandemic among postgraduate research students. This study discovered positive associations between poor sleep habits and reported stress or generalized anxiety among postgraduate research students. Postgraduate research students' anxiety levels and perceived stress during the COVID-19 pandemic were shown to be connected with characteristics such as ethnicity, medical history (eg, systemic disease, musculoskeletal diseases, depression or stress), and poor sleep hygiene. The present study highlights that postgraduate research students may be prone to poor sleep hygiene, high anxiety levels, or perceived stress during the current pandemic. Longitudinal studies are warranted to explore the long-term predictors of poor sleep hygiene, anxiety levels, or perceived stress over time. The findings show that it is imperative to consider the numerous facets of mental health (ie, anxiety levels and perceived stress) and the multifaceted links to sleep in university students. Since the length and severity of the outbreak are expected to be longer, future studies are warranted to develop and implement strategies to improve sleep hygiene, anxiety levels, and perceived stress in postgraduate research students.

Disclosure

The authors report no conflicts of interest in this publication.

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