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# Exploring the association between mental health and subjective sleep quality during the COVID-19 pandemic among Bangladeshi university students

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ABSTRACT

The outbreak of new coronavirus disease (COVID-19) has triggered a global panic, affecting the mental well-being of people of all ages, including students. The aim of this study was to explore the relationship between self-reported mental health concerns and subjective sleep quality of the Bangladeshi university students during the COVID-19 pandemic. A web-based cross-sectional study was conducted to maintain the social distancing recommended by the World Health Organization. There were 1,317 student responses from 49 universities across Bangladesh. Data was analyzed by executing both bi-variate and multivariate analysis. Findings indicate that 27.1%, 51.0%, 45.9%, and 86.0% of students had poor subjective sleep quality, anxiety, depression, and fear of COVID-19, respectively. Anxiety (AOR = 1.09, 95% CI: 1.06–1.12, $p < 0.001$) was a risk factor for increasing the poor subjective sleep quality of university students. In contrast, the odds of poor subjective sleep quality were lower with increasing the score of depression (AOR = 0.88, 95% CI: 0.86–0.90, $p < 0.001$) and fear of COVID-19 (AOR = 0.97, 95% CI: 0.94–0.99, $p < 0.05$). Compared to public university students, private university students were more likely to report poor subjective sleep quality since the pandemic began. Therefore, it is strongly recommended that psychiatric conditions of university students should be monitored during the COVID-19 epidemic, and necessary strategies, such as allocation of resources, implementation of awareness programs, establishment of psychological counselling unit, should carefully be devised.

## 1. Introduction

The outbreak of the new coronavirus disease (COVID-19) has triggered a substantial rise in public health concerns across the globe. As of 26 August 2020, there were 105.4 million confirmed cases of the COVID-19 infections with nearly 2.3 million fatalities, mostly in Europe and Americas (World Health Organization, 2021a). Though the case fatality rate of the COVID-19 was relatively lower than other viruses from the Corona family – the SARS and the MERS (Deng and Peng, 2020), it threatened to collapse the global health system in the absence of antidotes. The virus contaminated the entire world within a short time with an unexpected surge of the human-to-human transmission rate. Thus, it was declared as a global pandemic on 11 March 2020 and the World Health Organization (World Health Organization, 2020) devised comprehensive measures to suppress the rapid spread of the virus at clusters and community levels to minimize fatalities. Subsequently, the international community mobilized a range of strict anti-epidemic measures to thwart the human-to-human transmission, such as (i) imposing travel restriction on foreign nationals, (ii) shutting down the entire transit system, (iii) closing the public spaces as well as educational

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institutions etc. (Ahmed et al., 2020; Cao et al., 2020; Chen and Yuan, 2020; Odriozola-González et al., 2020; Savitsky et al., 2020). Measures were also implemented to quarantine and isolate individuals who had been infected or were suspected of having COVID-19 (Dsouza et al., 2020). The threatening effects of these measures on mental stabilities are reported across different cohorts (Islam et al., 2020b; Khan et al., 2020b).

Like many other countries, Bangladesh imposed country-wide lockdown in the disguise of 'general holidays' from 26 March 2020 and onward to contain the spread of the highly contagious virus and to enact social distancing by a mandatory home quarantine following the detection of the first COVID-19 case on 8 March 2020 (Bhuiyan et al., 2020; Jahid, 2020; The Daily Star, 2020a). The educational institutions, however, were closed from 18 March 2020 to 31 March 2020 at first, and later extended to the end of December in phases as the cases of COVID-19 rose across the country (Abdullah, 2020; Dhaka Tribune, 2020a, 2020b). Although the government suspended the 'general holidays' from 31 May 2020 to resume regular activities (The Daily Star, 2020b), the class-based teaching in educational institutions is still suspended, and only the administrative activities are ongoing in the country. A total of 538,062 COVID-19 cases and 8,205 deaths were reported in Bangladesh as of 7 February 2021 (World Health Organization, 2021b).

Students are agitated largely by high academic expectations, successful academic completion, and persuasion of future academic as well as professional career (Beiter et al., 2015), while some may feel psychologically distressed for being away from family and home environment, with competitive or jealous peers, and for living alone in the dormitory (Rezaei-Adryani et al., 2007). Studies revealed that the most common mental health problems among students in higher academia are anxiety and depression disorder (Abdallah and Gabr, 2014; Ballester et al., 2020; Beiter et al., 2015; Islam et al., 2020b; Lun et al., 2018), and it becomes more complex with increasing sleep disorder due to heightened academic pressure and mental distress (Zou et al., 2020).

During stressful life events, the psychological problems undoubtedly aggravated, and the quality of life remains hampered even after the events. Evidently, increased psychological sufferings are reported during the current COVID-19 pandemic (Islam et al., 2020a; Khan et al., 2020a; Shovo et al., 2021), and its extreme effect, that is, suicide rate increment has also been reported throughout the world (Dsouza et al., 2020; Mamun and Ullah, 2020). Similar observation was reported during the influenza pandemic in 1918–19 among the US general people (Wasserman, 1992), and among the elderly people in Hong Kong during the SARS outbreak in 2002 (Cheung et al., 2008). However, the psychological sufferings among students (especially, college and university students) are highly manifested, because of issues related to (i) sudden closure of schooling as of strict isolation, (ii) residing away from families during the critical time, (iii) postponement of events like graduation ceremonies, study exchanges etc., (iv) losing some of students' part-time jobs because local businesses are closed, (vi) facing difficulties due to accessing online schooling etc. (Khan et al., 2020b). In Bangladesh, a suicide pact was reported between a student and the mother because of online schooling related issue that caused family conflicts (Mamun et al., 2020a).

The ongoing COVID-19 pandemic is no exception, as the prolonged confinement through home quarantine or social distancing intensifies the mental health problems (Brooks et al., 2020). The home quarantine or social distancing and its emanated issues, like loneliness, missing family support etc., were responsible for a larger portion of the COVID-19 related suicide (Cao et al., 2020; Dsouza et al., 2020). The mental health problems, such as anxiety, depression, suicidal ideation, deterioration of sleep quality and sexual life, are reported among university students by the global studies (Islam et al., 2020a; Kaparounaki et al., 2020; Odriozola-González et al., 2020). A study on Russian and Belarussian university students showed that students in quarantine or self-isolation had developed a higher sense of loneliness, depression and other mental health problems compared to those with no quarantine or isolation (Gritsenko et al., 2020). Besides, impacts upon the academic, health, social and economic aspects are also observed to this cohort (Cao et al., 2020; Odriozola-González et al., 2020).

To our knowledge, only a handful of work concerning the mental health conditions of university students was conducted in Bangladesh during the COVID-19 pandemic (Ela et al., 2021; Islam et al., 2020a; Khan et al., 2020a; Shovo et al., 2021). This study was, therefore, conducted to serve twofold objectives – (i) to explore the presence of anxiety, depression, fear of COVID-19, and subjective sleep quality among the university students; and (ii) to examine the association between socio-demographics, anxiety, depression, and fear of COVID-19 with subjective sleep quality. It is expected that the empirical evidence from the present findings would provide the ground to prescribe effective strategies and action plans to minimize the psychological traumas of the cohort in future emergencies.

## 2. Methods

### 2.1. Study procedure

This web-based cross-sectional study was carried out in the last week of April 2020. Data were collected using a self-administered e-questionnaire to comply with the WHO recommended social distancing to avoid face-to-face contact with the potential participants. The participants were recruited in the online survey through snowball sampling from one source to another. The participants were invited through their Facebook and Messenger accounts and requested to share the link of the e-questionnaire with others in their social networks. The e-questionnaire, developed using Google Form by the study group after reviewing relevant literature, contained close-ended items as well as Likert-scale questions on socio-demographic and mental health issues. The target population was the university students of Bangladesh, and based on specific criteria, e.g., (i) a Bangladeshi and (ii) enrolled in a public or private university, a total of 1,365 anonymous responses from 49 universities across the country were received. Out of the initial responses, 1,317 responses were deemed suitable to retain in this study after thorough scrutiny (see Figure 1).

### 2.2. Ethical issues

This study was conducted with a formal ethical approval from the Khulna University Ethical Clearance Committee (Reference No. – KUECC – 2020/11/06). The participants responded anonymously to the e-questionnaire by filling up an informed consent letter in the first section of the e-questionnaire. In the consent form, all the participants were provided with detailed information concerning the research purpose, the confidentiality of information, and the right to revoke the participation without prior justification.

### 2.3. Measures

#### 2.3.1. Socio-demographics

Some specific factors, such as sex (Cao et al., 2020; Kalyani et al., 2017), enrolled program (Kalyani et al., 2017) as well as type of university (i.e., public versus private), were considered as the components of socio-demographics to understand the prevalence of psychological problems in the context of Bangladesh.

#### 2.3.2. Anxiety

Anxiety was measured by the Generalized Anxiety Disorder (GAD-7) (Spitzer et al., 2006). The self-reporting GAD-7 consisted of seven items with a four-point response option, ranging from '0 = not at all,' '1 = several days,' '2 = more than half the days' and '3 = nearly every day,' assessing the prevalence of anxiety symptoms during the last two weeks. The total score ranged from '0' to '21,' and a total score of 10 or higher

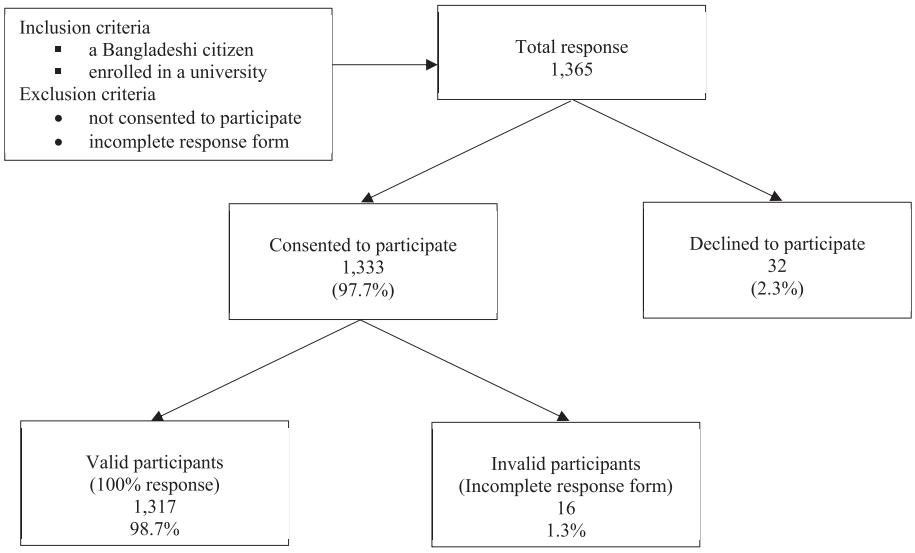


**Figure 1.** Flow chart of study sample.

signifies the presence of anxiety symptoms. The GAD-7 has widely been used as a reliable instrument to assess the anxiety disorder among adolescents (Spitzer et al., 2006), adults (Gao et al., 2020; Hossain et al., 2020) as well as students (Savitsky et al., 2020). The Cronbach's α in the present study was very good (α = 0.87).

#### 2.3.3. Depression

Depression was assessed by the WHO-Five Well-being Index (WHO-5) (Mental Health Centre North Zealand, 2020). The WHO-5 – a self-reporting scale – contained five statements to comprehend the feelings of an individual over the last two weeks. The six-point response options were 'all the time = 5,' 'most of the time = 4,' 'more than half of the time = 3,' 'less than half of the time = 2,' 'some of the time = 1' and 'at no time = 0.' The raw score ranged from '0' to '25,' and a summed score below 13 indicates poor well-being or presence of depression among the participants (Mental Health Centre North Zealand, 2020). The WHO-5 proved to be an effective tool to measure depression during the COVID-19 pandemic (Gao et al., 2020; Hossain et al., 2020). The Cronbach's α in this study was very good (α = 0.88).

#### 2.3.4. Fear of COVID-19

Fear related to COVID-19 issues was assessed by the fear of COVID-19 scale (FCV–19S) (Ahorsu et al., 2020). The FCV-19S, a seven-item unidimensional scale, used five-point Likert-type responses, including 'strongly disagree = 1,' 'disagree = 2,' 'neither agree nor disagree = 3,' 'agree = 4' and 'strongly agree = 5.' The higher score – ranging from 7 to 35 – signifies greater fear towards COVID-19. In the current study, we used the seven-item unidimensional construct with a four-point Likert-type response (Shovo et al., 2021), where a higher score signifies a greater fear of COVID-19 (Gritsenko et al., 2020). The Cronbach's α in the present study was very good (α = 0.87).

#### 2.3.5. Subjective sleep quality

Sleep quality was assessed by the Pittsburg Sleep Quality Index (PSQI) (Buysse et al., 1989). The self-reporting PSQI, consisting of seven components with 24 questions, assesses the quality of sleep during the previous month. Each element has its unique score, ranging from '0' to '3' with higher points signifies poor sleep quality. In this study, we used only the first component of PSQI – the 'subjective sleep quality' – on a four-point scale, including 'very good = 0,' 'fairly good = 1,' 'fairly bad = 2' and 'very bad = 3.' The responses were recoded into 'good' ('very good' and 'fairly good') and 'bad' ('fairly bad' and 'very bad').

### 2.4. Statistical analysis

Data were analyzed in three consecutive stages using the statistical package for social sciences (SPSS) v20. Firstly, descriptive statistics, including frequency and percentage analysis as well as measures of central tendency (e.g., mean, and standard deviation), was used to present the details of the participants and their mental health status. Secondly, bi-variate analyses were executed by *t*-test (*t*) and Pearson's correlation (*r*), where the former was performed to measure the differences between sexes, type of university, and enrolled program about their mental health conditions, and the latter was used to assess underlying correlations among the mental health conditions. The results of the *t*-test were presented by considering two conditions from Levene's test for homogeneity of data. The results for the actual independent samples *t*-test were considered, if Levene's test indicates that the variances are equal across the two groups ($p > 0.05$). If Levene's test indicates that the variances are not equal across the two groups (i.e., $p < 0.05$), then the alternative results of the independent samples *t*-test were presented in this study. Shapiro–Wilk test was used to test the normality of data and the data were normally distributed ($p < 0.05$). Using the mean and standard deviation this study also measured the effect size for two independent groups as per the threshold suggested by Cohen (1988). Finally, the multivariable logistic regression model was performed to predict subjective sleep quality, and the findings were shown using the adjusted odds ratio (AOR) with 95% confidence intervals (95% CI). Additionally, this study also assessed the multicollinearity of the data and Hosmer–Lemeshow test for goodness of fit for multivariable logistic regression model. The existence of multicollinearity amongst the anxiety, depression, fear of COVID 19, sex, enrolled program, and type of university were examined using the variance inflation factor (VIF). When the mean value of VIF was less than 10, it was considered that there is no existence of multicollinearity. Furthermore, when the *p* value of Hosmer–Lemeshow test for goodness of fit for multivariable logistic regression model was smaller, it signified that the model is a poor fit.

## 3. Results

Among the participants (n = 1,317), 58.2% were male and the rests were female (41.8%). More than 60% of the participants enrolled in undergraduate programs. Out of the total participants, around 90% of students were public university students. Table 1 shows the prevalence of anxiety, depression, fear of COVID-19 and subjective sleep quality of the participants in relation to socio-demographics. The overall prevalence of

anxiety, depression and fear of COVID-19 was 51.0%, 45.9% and 86.0%, respectively. About 27% of the university students reported to have poor subjective sleep quality over the last month (see Table 1).

The results, presented in Table 1, also demonstrate that female students were exhibiting more symptoms of anxiety (54.4%), depression (51.5%), fear of COVID-19 (92.0%) and experiencing poor subjective sleep quality (31.6%) compared to their male counterparts. Students enrolled in graduate and post-graduate programs had higher anxiety (51.2%), fear of COVID-19 (86.6%) and poor subjective sleep quality (28.0%) with an exception to depression which was greater among the undergraduate students (47%). Likewise, private university students reported to have higher anxiety (51.5%), fear of COVID-19 (86.7%) and poor subjective sleep quality (32.1%) compared to their public university contemporaries, whereas the latter reported to have greater depression (47.3%) than private university students.

The results, analyzed by independent *t*-test, demonstrate that the mean score of depression was higher among male students than females (13.17 versus 11.88; $t$ [1315] = 3.750, $p < 0.001$). However, the mean values of anxiety (9.46 versus 10.57; $t$ [1315] = -3.606, $p < 0.001$), fear of COVID-19 (11.31 versus 12.63; $t$ [1315] = -5.896, $p < 0.001$), and subjective sleep quality (8.11 versus 9.08; $t$ [1315] = -3.023, $p < 0.01$) were lower for male students compared to their female counterparts (see Table 2).

Based on Table 3, depression was significantly different between public and private students (12.41 versus 14.16; $t$ [1315] = -3.409, $p < 0.001$) as private university students reported higher score of depression. However, no significant difference observed for anxiety, the fear of COVID-19, and subjective sleep quality between public and private students ($p > 0.05$).

On the contrary, the intensity of anxiety (9.92 versus 9.92), depression (12.56 versus 12.77) and fear of COVID-19 (11.88 versus 11.82) symptoms was similar between the undergraduate and graduate and post-graduate students. They differ only in subjective sleep quality (8.27 versus 8.96; $t$ [1315] = -2.099, $p < 0.05$) (see Table 4).

The findings from Table 5 reveal the correlation between mental health problems with subjective sleep quality. However, correlation analysis only measures the association between two quantitative variables and there is no adjustment effect of others considered variables. It was found that students' anxiety, depression, and fear of COVID-19 were significantly related to subjective sleep quality ($p < 0.001$). Among the variables, anxiety ($r = 0.301$, $p < 0.001$) and fear of COVID-19 ($r = 0.283$, $p < 0.001$) had positive relation with subjective sleep quality, whereas it was negative for depression ($r = -0.217$, $p < 0.001$).

Results of binary logistic regression are presented in Table 6. The VIF of binary logistic regression model provides a measure of multicollinearity among the independent variables. The results of binary logistic regression model provide the value of VIF were less than 10, so there is no existence of multicollinearity problem. Findings show that anxiety, depression, fear of COVID-19 and type of university significantly affect the subjective sleep quality after adjusting; however, sex and enrolled degree program did not show any significant relationship with subjective sleep quality. The adjusted odds of poor subjective sleep quality were higher with an increase in the value of anxiety (AOR = 1.09, 95% CI: 1.06–1.12, $p < 0.001$), whereas the adjusted odds of poor subjective sleep quality were lower with an increase in the value of depression (AOR = 0.88, 95% CI: 0.86–0.90, $p < 0.001$) and fear of COVID-19 (AOR = 0.97, 95% CI: 0.94–0.99, $p < 0.05$). The results also indicated that private university was a risk factor for poor subjective sleep quality (AOR = 1.51, 95% CI = 1.02–2.25, $p < 0.05$). Hosmer–Lemeshow test statistic value for the multivariable logistic regression model was 5.86 ($\chi^2 = 5.86$) with $p$ value = 0.663. This large $p$ value of Hosmer–Lemeshow test indicate that the multivariable logistic regression model was well fitted.

## 4. Discussion

Following the outbreak of COVID-19, most of the countries of the world opted for lockdown, home quarantine and social distancing as preventive measures to curb the highly infectious virus (Dsouza et al., 2020). The prolonged confinement deteriorates the mental health state of people, as observed in previous such experiences (Brooks et al., 2020; Hawryluck et al., 2004), especially among students (Main et al., 2011). The recent studies conducted during the COVID-19 pandemic on students across the world also observed a dramatic change in the prevalence of mental health problems, including anxiety, depression, fear of COVID-19 as well as subjective sleep quality. For example, one in four college students in China reportedly show the presence of mild to severe anxiety (Cao et al., 2020), whereas Spanish students exhibited heightened depression and anxiety during the COVID-19 pandemic (Odriozola-González et al., 2020). A study in East European countries suggested that more than half of the students have been experiencing a sharp rise of depression and fear of COVID-19 (Gritsenko et al., 2020), while another study on students in the USA indicated that students are experiencing irregular and insufficient sleep during stay-at-home (Wright et al., 2020). The results of the current study complemented the findings of previous studies as the overall prevalence of anxiety, depression, fear of COVID-19 and poor subjective sleep quality among the university students was 51.0%, 45.9%, 86.0% and 27.1%, respectively. Present study results, therefore, suggest that university students in Bangladesh are going through negative psycho-emotional conditions during the pandemic.

The findings also found variations in mental health status in reference to socio-demographic variables. For example, female students have been experiencing heightened anxiety, fear of COVID-19 and poor subjective sleep quality compared to the male counterparts, whereas males were reportedly suffering from a greater depression disorder than females. These findings contradict with a previous Bangladeshi study that found no significant sex-based difference in depression, anxiety, and stress among university students (Mamun et al., 2019). Some other studies, in

**Table 1.** Prevalence of anxiety, depression, fear of COVID-19 and sleep quality based on socio-demographics.

| Variables | Total | | Anxiety | | Depression | | Fear of COVID-19 | | Poor subjective sleep quality | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % |
| **Overall** | 1,317 | 100 | 672 | 51.0 | 604 | 45.9 | 1,133 | 86.0 | 357 | 27.1 |
| **Sex** | | | | | | | | | | |
| Male | 766 | 58.2 | 372 | 48.6 | 320 | 41.8 | 626 | 81.7 | 183 | 23.9 |
| Female | 551 | 41.8 | 300 | 54.4 | 284 | 51.5 | 507 | 92.0 | 174 | 31.6 |
| **Enrolled program** | | | | | | | | | | |
| Undergraduate | 846 | 64.2 | 431 | 50.9 | 398 | 47.0 | 725 | 85.7 | 225 | 26.6 |
| Graduate & post-graduate | 471 | 35.8 | 241 | 51.2 | 206 | 43.7 | 408 | 86.6 | 132 | 28.0 |
| **Type of university** | | | | | | | | | | |
| Public | 1,152 | 87.5 | 587 | 51.0 | 545 | 47.3 | 990 | 85.9 | 304 | 26.4 |
| Private | 165 | 12.5 | 85 | 51.5 | 59 | 35.8 | 143 | 86.7 | 53 | 32.1 |

**Table 2.** Comparison of the mean score of anxiety, depression, fear of COVID-19 and subjective sleep quality of university students by sex.

| Variable | Levene's test for homogeneity of variances | | Male | | | Female | | | Cohen's *d* | Effect size | *t*-test | *p* value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | *p* value | Mean ± SD | Shapiro-Wilk test for normality | | Mean ± SD | Shapiro-Wilk test for normality | | | | | |
| | | | | Statistic | *p* value | | Statistic | *p* value | | | | |
| Anxiety | 0.054 | 0.816 | 9.46 ± 5.56 | 0.973 | <0.001 | 10.57 ± 5.52 | 0.972 | <0.001 | -0.20 | -0.10 | -3.606 | <0.001 |
| Depression | 2.683 | 0.102 | 13.17 ± 6.30 | 0.971 | <0.001 | 11.88 ± 5.94 | 0.979 | <0.001 | 0.21 | 0.11 | 3.750 | <0.001 |
| Fear of COVID-19* | 8.236 | 0.004 | 11.31 ± 4.31 | 0.987 | <0.001 | 12.63 ± 3.77 | 0.987 | <0.001 | -0.33 | -0.16 | -5.896 | <0.001 |
| Subjective sleep quality | 2.413 | 0.121 | 8.11 ± 5.81 | 0.958 | <0.001 | 9.08 ± 5.61 | 0.973 | <0.001 | -0.17 | -0.08 | -3.023 | 0.003 |

Note: * Homogeneity of variance has not been satisfied (p-value<0.05).

**Table 3.** Comparison of the mean score of anxiety, depression, fear of COVID-19 and subjective sleep quality of university students in view of the type of university.

| Variable | Levene's test for homogeneity of variances | | Public | | | Private | | | Cohen's *d* | Effect size | *t*-test | *p* value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | *p* value | Mean ± SD | Shapiro-Wilk test for normality | | Mean ± SD | Shapiro-Wilk test for normality | | | | | |
| | | | | Statistic | *p* value | | Statistic | *p* value | | | | |
| Anxiety* | 12.254 | <0.001 | 9.91 ± 5.46 | 0.975 | <0.001 | 10.04 ± 6.24 | 0.951 | <0.001 | -0.02 | -0.01 | -0.254 | 0.799 |
| Depression* | 13.095 | <0.001 | 12.41 ± 6.00 | 0.977 | <0.001 | 14.16 ± 7.19 | 0.942 | <0.001 | -0.26 | -0.13 | -2.978 | 0.003 |
| Fear of COVID-19 | 3.410 | 0.065 | 11.81 ± 4.06 | 0.987 | <0.001 | 12.17 ± 4.64 | 0.979 | 0.012 | -0.08 | -0.04 | -1.031 | 0.303 |
| Subjective sleep quality | 1.498 | 0.221 | 8.54 ± 5.66 | 0.967 | <0.001 | 8.34 ± 6.29 | 0.946 | <0.001 | 0.03 | 0.02 | 0.416 | 0.678 |

Note: *Homogeneity of variance has not been satisfied ($p$ value $< 0.05$).

**Table 4.** Comparison of the mean score of anxiety, depression, fear of COVID-19 and subjective sleep quality of university students based on enrolled program.

| Variable | Levene's test for homogeneity of variances | | Undergraduate | | | Graduate & postgraduate | | | Cohen's *d* | Effect size | *t*-test | *p* value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | *p* value | Mean ± SD | Shapiro-Wilk test for normality | | Mean ± SD | Shapiro-Wilk test for normality | | | | | |
| | | | | Statistic | *p* value | | Statistic | *p* value | | | | |
| Anxiety | 0.316 | 0.574 | 9.92 ± 5.50 | 0.975 | <0.001 | 9.92 ± 5.68 | 0.969 | <0.001 | 0.0 | 0.0 | 0.016 | 0.987 |
| Depression | 0.188 | 0.665 | 12.56 ± 6.21 | 0.976 | <0.001 | 12.77 ± 6.15 | 0.974 | <0.001 | -0.03 | -0.02 | -0.607 | 0.544 |
| Fear of COVID-19 | 0.633 | 0.426 | 11.88 ± 4.10 | 0.985 | <0.001 | 11.82 ± 4.22 | 0.988 | <0.001 | 0.01 | 0.01 | 0.270 | 0.787 |
| Subjective sleep quality | 0.011 | 0.917 | 8.27 ± 5.72 | 0.959 | <0.001 | 8.96 ± 5.75 | 0.972 | <0.001 | -0.12 | -0.06 | -2.099 | 0.036 |

**Table 5.** Results of partial correlation between of anxiety, depression, fear of COVID-19 and subjective sleep quality.

| Variables | | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 1 | Anxiety | 1.000 | | | |
| 2 | Depression | -0.316** | 1.000 | | |
| 3 | Fear of COVID-19 | 0.536** | -0.180** | 1.000 | |
| 4 | Subjective sleep quality | 0.301** | -0.217** | 0.283** | 1.000 |

**p < 0.001.

contrast, suggested that female students are psychologically more vulnerable than their male counterparts (Kalyani et al., 2017; Mamun and Griffiths, 2020). This may be possible because females are more likely to experience mood and anxiety disorders than males (Ballester et al., 2020; Lun et al., 2018). The discrepancies in mental health well-being between sexes can be attributed to a wide range of stressors,

**Table 6.** Results of binary logistic regression of effects of anxiety, depression, fear of COVID-19, sex, type of university and enrolled program on subjective sleep quality.

| Variables | VIF | B | SE | *p* value | AOR | 95% CI for AOR | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Anxiety | 1.510 | 0.089 | 0.014 | <0.001 | 1.09 | 1.06 | 1.12 |
| Depression | 1.129 | -0.129 | 0.010 | <0.001 | 0.88 | 0.86 | 0.90 |
| Fear of COVID-19 | 1.428 | -0.035 | 0.016 | 0.030 | 0.97 | 0.94 | 0.99 |
| Sex (male vs. female) | 1.036 | 0.077 | 0.136 | 0.570 | 1.08 | 0.83 | 1.41 |
| Enrolled program (undergraduate vs. graduate & postgraduate) | 1.007 | -0.036 | 0.139 | 0.794 | 0.96 | 0.74 | 1.27 |
| Type of university (public vs. private) | 1.022 | 0.415 | 0.202 | 0.040 | 1.51 | 1.02 | 2.25 |

Note: **VIF**. Variance inflation factor; **SE**. Standard error; **AOR**. Adjusted odds ratio; **CI**. Confidence interval.

including the educational, socioeconomic as well as cultural environment (Ballester et al., 2020; Cao et al., 2020; Kalyani et al., 2017). However, the exposure to 'misinformation' in social and mass media (Aker and Mıdık, 2020; Gao et al., 2020) with a growing sense of loneliness in the absence of interpersonal communication during lockdown (Abdallah and Gabr, 2014), lack of mental and financial support from family and friends (Abdallah and Gabr, 2014; Ballester et al., 2020) as well as uncertainty over academic and professional life (Cao et al., 2020) might have been related to the unprecedented increase of mental health problems among the university students in Bangladesh.

This study also investigated the differences between public and private university students regarding mental health sufferings. The results show that the mean score of anxiety, depression and fear of COVID-19 was higher among private university students, while poor subjective sleep quality was more prevalent among public university students. It is, however, found that the mean score of depression was only statistically significant, meaning public university students were more depressed than their counterparts from private university. A recent study in Bangladesh observed that a significant percentage of university students (46.4%) select a subject considering its career prospects. The same study reported that more than half of the university students, who selected a subject considering its prospects, were depressed (Sakib et al., 2020). However, the uncertainty over graduation as well as career prospects triggers mental instability, especially during the COVID-19 pandemic (Ela et al., 2021; Islam et al., 2020b). Moreover, the access to and use of smartphones and other electrical devices could be an important catalyst shaping the mental well-being of students in Bangladesh. Mamun and Griffiths (2019), in a recent Bangladeshi study on university students, observed a strong relationship between excessive social media use and its addiction with depression. Besides, the postponement of graduation, the uncertainty of both academic and professional career as well as loss of part-time jobs could be responsible for psychiatric sufferings among public university students (Cao et al., 2020; Islam et al., 2020b; Khan et al., 2020b; Lee, 2020). It is important to note that students from lower and middle-income families in Bangladesh generally enroll in public universities, a cheaper alternative to the out of reach private universities (Kono et al., 2018). The interruption of graduation followed by an uncertain professional career with a highly anticipated global recession (Ela et al., 2021; Sahu, 2020) could lead to a heightened depression among the public university students in Bangladesh.

In addition to sex and university-based differences in mental health well-being, the present study also investigated the dissimilarity based on programs enrolled by university students. No significant difference was observed between the undergraduate and the graduate and post-graduate students in experiencing mental health problems, with an exception to subjective sleep quality. Apparently, undergraduate students have been experiencing troubled sleep during the pandemic. These results, to some extent, complement the observation of Rezaei-Adryani et al. (2007) as they found no significant difference between two groups of university students in suffering from anxiety and depression. Simultaneously, the findings were also partially in line with Kalyani et al. (2017). They found a significant difference between students enrolled in three academic degrees, especially the undergraduate students were struggling to sleep. The higher values of subjective sleep quality for graduate and post-graduate students can be attributed to their academic and professional achievement and satisfaction, whereas the unexpected interruption of academic life in the form of delayed graduation (Khan et al., 2020b; Sahu, 2020) may have contributed to poor subjective sleep quality among the undergraduate students.

Apart from assessing the differences in the mental health condition of university students, this study also evaluated the mutual relation between socio-demographic characteristics, psychological conditions and subjective sleep quality. The results from the correlation analysis demonstrate that anxiety, depression, and fear of COVID-19 were significantly related to subjective sleep quality, where anxiety and fear of COVID-19 were positively related, and depression had a negative relation with subjective sleep quality. Previous studies also reported a negative relation between depression and subjective sleep quality. For example, Augner (2011) found a strong negative correlation between subjective sleep quality and depression among nursing and technical students in Austria. In the UK, another study reported a significant negative relationship between subjective sleep quality and depression and anxiety (Mayers et al., 2009).

The results from the logistic regression show that the anxiety, depression, fear of COVID-19 and type of university significantly influenced the subjective sleep quality of university students after adjusting sex, enrollment program and type of university. The subjective sleep quality of university students decreased with an increase in anxiety. In contrast, the subjective sleep quality improved as the values for depression increased. Furthermore, the subjective sleep quality of university students decreased with an increase in the value of fear of COVID-19. Generally, mental health issues like anxiety and depression negatively affect sleep quality, as earlier studies reported similar findings (Augner, 2011; Lund et al., 2010; Mayers et al., 2009). Besides, the fear of COVID-19 has also been adversely affected the subjective sleep quality of students, as reported in a recent study in Bangladesh (Shovo et al., 2021). Moreover, a study on Iranian medical students found a significant relation between sleep quality and anxiety as well as level of education, but observed no relation with depression (Kalyani et al., 2017). In China, Zou et al. (2020) reported that sleep quality depends on the magnitude of anxiety and depression among male college students. A previous Bangladeshi study on university students also found a significant association between longer and shorter sleep status with depression and stress; however, the relationship with anxiety was not ascertained (Mamun et al., 2019). A study on the Japanese population demonstrated that people with depression and anxiety history had poor sleep quality (Doi et al., 2000). Therefore, the results of this study demonstrate that mental health problems among students may lead to poor subjective sleep quality.

However, fear of COVID-19 and subjective sleep quality had a positive correlation, but they were negatively associated in regression analysis after adjusting some important explanatory variables. It is important to note that when the regression coefficient and the correlation between latent paradigms do not have same sign, the original relationship between the two has been suppressed. This may happen when the original relationship between the two variables is so close to zero; thus, a change in the sign basically reflects random disparity around zero. Another cause is real suppression when there is a significant predictor variable. This is essential to understand that the true relationship between the latent variables can be suppressed with the presence or effect of another predictor variable (Falk and Miller, 1992). Further studies are needed to justify such types of findings.

The validity of the present observation is subjected to various issues. For example, data were collected from participants during the early period of the pandemic. Thus, the findings have limited generalizability for other periods as mental health conditions are subject to time and space, and it can be fluctuated over time of the pandemic. An assessment of the participants' further experience over the coming weeks of prolonged lockdown would bring greater clarity about the phenomena reported here. Besides, self-rating scales were used for assessing anxiety, depression, as well as fear of COVID-19, without diagnosing through clinical means for measuring mental health problems. Moreover, the sleep quality was assessed only by 'subjective' sleep quality, instead of all seven components of the PSQI. Hence, the risk of overestimation and social desirability bias cannot be denied. Since the study was cross-sectional, the causal relationship cannot be determined. Furthermore, data were collected from a specific population, covering only university students, through social media only and may not be generalized to other settings and populations. A nationwide, large-scale study, including students at schools, colleges, *Madrasahs* – the sectarian educational institutions, would present different experiences and issues. Therefore, systematic longer follow-up studies are recommended to determine the

impact of the COVID-19 on the mental health of masses, including the university students of Bangladesh.

## 5. Conclusion

This study found that the university students in Bangladesh are mentally distressed during the pandemic as the presence of heightened anxiety, depression, fear of COVID-19, and poor subjective sleep quality among university students across the country has been observed. Like many lower middle-income countries, the allocation of resources on mental health services in the universities of Bangladesh is nominal; therefore, students with mental health problems remain unattended. Moreover, students are unaware about mental disorders and sometimes, they are reluctant to visit healthcare center, largely due to the fear of social stigma and social exclusion (Mamun et al., 2020b). We, therefore, strongly advocate to plan and implement programs aimed at strengthening the state of mental health for university students during the pandemic. We also suggest establishing a psychological counseling unit in the universities that would allow the students to get connected with professional psychiatrists through the internet or via cell phone for a direct interview and mental health assessment. The University Grants Commission (UGC) of Bangladesh, together with health authorities of the government, should provide the necessary information by setting up a support network using available online platforms to assist the students, faculties and other people involved in higher academia to resist mental ailments during the ongoing health emergency. In Bangladesh, with clear shortage of necessary resources and experts, we need to ensure optimum utilization of all possible assets, including human, financial, and infrastructural, through the effective plan of actions to detect and deliver the required psychiatric services across the country, including the remote resource-poor settings, to minimize psychological distress during the COVID-19 pandemic.

## Declarations

### *Author contribution statement*

Md. Tanvir Hossain: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Taufiq-E-Ahmed Shovo, Nusrat Jahan: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Aysha Seddeque, Mohammed A. Mamun: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Benojir Ahammed: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Bayezid Khan: Performed the experiments; Wrote the paper.

Md. Nazrul Islam: Performed the experiments.

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### *Data availability statement*

Data associated with this study is available at Harvard Dataverse under: https://doi.org/10.7910/DVN/94KDOL.

### *Declaration of interests statement*

The authors declare no conflict of interest.

### *Additional information*

No additional information is available for this paper.

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