



Insomnia in Bangladeshi Young Adults During the COVID-19 Pandemic: The Role of Behavioral Factors, COVID-19 Risk and Fear, and Mental Health Issues

Mahmudul Hasan^{1,2} · Zeba Maliha^{1,3} · Abidur Rahman^{1,2} · Mohammed A. Mamun^{1,4}

Received: 25 June 2021 / Revised: 23 July 2021 / Accepted: 4 August 2021 / Published online: 16 August 2021
© The Author(s), under exclusive licence to Springer Nature Singapore Pte Ltd. 2021

Abstract

Background Given the importance of sleep, several studies were conducted during the first wave of the COVID-19 pandemic in Bangladesh, but no study was conducted during the second wave. Thus, this study assessed the prevalence rate, associated factors, and predictive models of insomnia during the second wave of the COVID-19 pandemic.

Methods An online-based cross-sectional survey was conducted during the second wave of the pandemic (within April 1–13, 2021) and collected information on sociodemographic, behavior and health, COVID-19 risk, fear of COVID-19, depression, anxiety, suicidality, and insomnia. A total of 756 data from Bangladeshi young adults (22.24 ± 4.39 years) were finally analyzed.

Results About 13% of the participants ($n = 98$ out of a total of 756) had the symptoms of insomnia. Insomnia had a significant gender difference, where females were more prone to be insomniac. Besides, middle class, urban residence, smoking status, not engaging in physical exercise, poor health status, and multi-comorbidities were also profoundly associated with insomnia. In addition, fear of COVID-19, COVID-19 risk, and mental health problems (i.e., depression, anxiety, and suicidality) showed a significant relationship in terms of insomnia. A total of 31.2% variance predicting insomnia was identified considering all of the studied variables.

Conclusions The prevalence of insomnia reported herein seems relatively lower than the prior studies, but this figure is not neglectable. Thus, the identified associated factors are highly suggested to consider in policy actions with a special focus on mental health problems to elevate the risk of sleep problems.

Keywords COVID-19 insomnia · Psychological impact · Sleep problems · Insomnia · Prevalence and risk factors · Insomnia in Bangladesh

1 Introduction

Sleep problems or insomnia is one of the mental health problems affecting the quality of life. Sleep is regulated by melatonin hormone and adenosine compounds, where

any disruptions lead to problematic sleep habits [1, 2]. The symptoms of insomnia include (i) unable to fall into a deep sleep at night, (ii) wake up suddenly at night, (iii) wake up too early, (iv) being tired after a night sleep, (v) mental health issues such as irritability, depression or anxiety, (vi) difficult to pay attention or focus on work, (vii) increase error or accident, (viii) worry about sleep, etc. [3, 4]. Sleep is needed to maintain healthy brain function and emotional wellbeing and play a vital role in physical health by healing the heart and blood vessels [1, 5]. Any disruptions in sleep or its deficiency affect this process and lead to a condition such as cardiac disease, high blood pressure, diabetes mellitus, stroke, etc. [5].

In December 2019, the first case of COVID-19 is reported in China. Subsequently, with its rapid transmission rate, the WHO declares the situation as a pandemic. Likely other

✉ Mohammed A. Mamun
mamunphi46@gmail.com

¹ CHINTA Research Bangladesh, Savar, Dhaka, Bangladesh

² Department of Biochemistry and Molecular Biology, University of Rajshahi, Rajshahi, Bangladesh

³ Bangabandhu Sheikh Mujib Medical College, Faridpur, Bangladesh

⁴ Department of Public Health and Informatics, Jahangirnagar University, Dhaka, Bangladesh

countries, the government of Bangladesh imposes a lockdown on 26 March 2020, where the first COVID-19 case is detected on 8 March 2020 in the country [6]. There is enough evidence suggesting the impact of lockdown on economic conditions and mental wellbeing. Economic disruptions made by the pandemic is reported as the prominent suicide stressors in Bangladesh [7], which links to worsening mental health conditions, as suggested by the recent systematic reviews of the studies [7, 8]. There are a number of studies on mental health issues like depression, anxiety, and stress; however, sleep problems are somewhat less studied in Bangladesh, although it is a major mental disorder [8]. Recently, a Bangladeshi systematic review comprising of six studies suggests that having insomnia problems ranging from 18 to 46.3%, where the rate is 23% to 46.3%, 18.6% to 44.2%, and 27.1% for the general people, healthcare workers, and students, respectively [9].

Insomnia is associated with mental health impairments, including moodiness increment, productivity reduction, even though it increases the risk of accidental events, including suicide [4, 10, 11]. In the COVID-19 pandemic context, maintaining sleep hygiene is highly suggested because it helps in strengthening the immune system, where the COVID-19-infected people can be more vulnerable to sleep problems [12, 13]. Given the importance of sleep, several studies were conducted during the first wave of the pandemic in Bangladesh [14–19], but the magnitude of insomnia and its associated factors during the second wave is yet to be investigated. In addition, there is a lack of studies using any models for estimating the insomnia predictors; therefore, what is the predictive role of factors related to sociodemographic, behavioral and health, COVID-19 risk and fear, and mental health issues is estimated in this study.

1.1 Methods

1.1.1 Study Procedure, Participants, and Ethics

The present cross-sectional study was conducted through an online survey between April 1 and 13, 2020, among the Bangladeshi young adults. The online survey link was circulated within the popular Bangladeshi social media platforms (i.e., Facebook, WhatsApp). The participants were further requested to circulate the link to their networks. Approximately, a total of 782 participants fill-up the form, and after the removal of the incomplete questionnaire, 756 data were kept for final analysis. The criteria for participating in this study included being a Bangladeshi young adult resident. An IRB approval was granted by the Institute of Allergy and Clinical Immunology of Bangladesh, Dhaka, Bangladesh, for conducting the study (Reference: IRBIACIB/CEC/03202032). An online consent form was required for participating in the study.

1.2 Measures

1.2.1 Sociodemographic Factors

This survey collected basic sociodemographic information such as age, gender, marital status, religion, educational qualification, monthly family income, profession, current residence status, etc. Socio-economic status was categorized into three groups (i.e., lower class, middle class, and higher class, based on an interval of 15,000 Bangladeshi Taka (BDT) monthly family income) following prior Bangladeshi studies [20].

1.2.2 Behavioral Health-Related Questions

Behavior-related questions such as smoking status, drug using (consuming alcohol or using other illicit substances), and physical exercise status were collected. The participants were asked if they performed at least 30 min of physical exercise daily to assess their physical exercise status. In addition, perceived self-rated health condition was evaluated using a 5-point Likert item (very good to very bad), whereas a binary response was used to determine their comorbidity status (i.e., asthma, hypertension, heart disease, cardiovascular disease, cancer, diabetes, and others).

1.2.3 COVID-19 Risk-Related Questions

A total of three items with binary responses were included to assess the participants' COVID-19 risk. First of all, if the participants were infected with the virus were assessed, whereas infection and deaths of their family members or friends were also evaluated. Then, in summing up these 3-items [(i) personal COVID-19 infection, (ii) friend and family member COVID-19 infection, and (iii) friend and family member COVID-19 death], a continuous variable was generated, where the higher scores indicate the higher risk of COVID-19.

1.2.4 Fear of COVID-19 Scale

Fear of COVID-19 was assessed using the Fear of COVID-19 Scale (FCV-19S) [21, 22]. The FCV-19S comprises a total of 7-items (e.g., "I am afraid of losing my life because of coronavirus-19"), where responses were recorded on a 5-point Likert scale (1 = strongly disagree, to 5 = strongly agree). The score ranges between 7 and 35, whereas the higher score indicates the greater fear of COVID-19. In the present study, Cronbach's alpha was 0.88.

1.2.5 Depression and Anxiety

Mental health outcomes such as depression and anxiety were assessed using the Patient Health Questionnaire 4 (PHQ-4) [23]. The PHQ-4 is an ultra-brief self-report questionnaire that consists of a 2-item depression scale (PHQ-2; e.g., “Little interest or pleasure in doing things”) and a 2-item anxiety scale (GAD-2; e.g., “Feeling nervous, anxious or on edge”), whereas each items’ responses were recorded on a 4-point Likert scale (0 = not at all, to 3 = nearly every day). The total PHQ-2 and GAD-2 sum scores range from 0 to 6, whereas a score of ≥ 3 was used for cutoff points for both depression and anxiety. In the present study, Cronbach’s alpha was 0.7.

1.2.6 Suicidality

Suicidality was assessed from the last item of the Montgomery-Asberg Depression Rating Scale [24]. The following instruction was given for rating their response: “feeling that life is not worth living, that a natural death would be welcome, suicidal thoughts, and the preparations for suicide; suicidal attempts should not in themselves influence the rating”. The item was rated on a 7-point Likert scale based on the scale scoring criteria, whereas the higher scores indicate higher suicidality. However, having at least symptoms of ‘frustrated about life and suicidal thoughts float in the head’, and ‘above’ was donated for suicidality cutoff point.

1.2.7 Insomnia

Insomnia was assessed by the two-item Insomnia Severity Index (i.e., “satisfied/dissatisfied with current sleep pattern”, and “interferences with daily functioning”). Each item consists of a 5-point Likert scale (0 = very satisfied to 4 = very dissatisfied). The total score ranges from 0 to 8, whereas a score of ≥ 6 was used for cutoff points for insomnia. This cutoff point has a sensitivity of 84% and a specificity of 76% [25]. In the present study, Cronbach’s alpha was 0.76.

1.3 Statistical Analysis

Data were analyzed using the Statistical Package for Social Science (SPSS) version 25. Before conducting the formal analysis, data were cleaned by Microsoft Excel 2019. Descriptive statistics (i.e., percentage, frequency, mean and standard deviation), independent *t* test, analysis of variance test (ANOVA), and Pearson correlation tests were performed. In addition, multiple hierarchical regression analysis was conducted utilizing insomnia as the dependent variable. Normality and multicollinearity (i.e., VIF and tolerance test) were also investigated in the present study, and no issues were found. A *p* value of < 0.05 was set as statistically significant with a 95% of confidence interval.

2 Results

2.1 Characteristics of the Participants

In total participants ($N = 756$), more than half of them were males (59%), and the mean age was $22.24 (\pm 4.39)$ years. Most of the participants were unmarried (90.6%), Muslim (89.4%), and 80% had higher education status. Moreover, 12.2% of the participants were smokers, 1.9% used drugs, and 46.0% reported exercising. Although 27.2% of the participants reported having comorbidities, 4.0% precepted their health as bad. About 6.0% were infected with COVID-19, but 42.9% reported anyone of their families had been infected with the virus. Moreover, 35.1%, 24.1%, and 8.2% of the participants had depression, anxiety, and suicidality, respectively (Table 1). About 13% of the participants (98 out of 756) were insomniac based on 2-item Insomnia Severity Index.

2.2 Distribution of Insomnia Mean Scores

Of the sociodemographic variables, gender, socio-economic status, and current residence were significantly associated with insomnia. That is, participants being female and urban residents were prone to sleep problems (3.22 ± 2.09 vs. 2.78 ± 2.14 ; $t = 2.820$, $p = 0.005$; and 2.59 ± 1.98 vs. 3.16 ± 2.18 ; $t = 3.503$, $p < 0.001$); whereas lower class participants had a lower score of insomnia ($F = 4.804$, $p = 0.008$). Similarly, participants being a smoker, not performing physical exercise, having higher health problems reported as vulnerable to insomnia. Although having a history of the participants’ COVID-19 infection was not significantly associated with insomnia, participants who reported that their friends and family members being infected or died by COVID-19 were at a higher risk of insomnia ($t = -3.846$, $p < 0.001$ and $t = -2.152$, $p = 0.032$, respectively). In addition, insomnia was more prevalent in the participants suffering from mental health problems like depression, anxiety, and suicidality (Table 1).

Table 2 presents correlations of the continuous variables with insomnia. There was a significant positive correlation of total comorbidities ($r = 0.159$), COVID-19 risk ($r = 0.137$), fear of COVID-19 ($r = 0.212$), depression ($r = 0.292$), anxiety ($r = 0.475$), and suicidality ($r = 0.297$) with insomnia.

2.3 Predictive Models for the Insomnia

Table 3 presents a multiple hierarchical regression analysis with a total of 4 models for predicting the factors

Table 1 Associations between the studied variables and insomnia

Variables	Total sample <i>N</i> , %	Insomnia		
		Mean and SD	<i>F/t</i> test value	<i>p</i> value
Sociodemographic variables				
Age (years)	22.24 ± 4.39			
≤ 20	228, 30.2%	2.74 ± 2.11	2.143	0.118
21–23	362, 47.9%	3.11 ± 2.16		
≥ 24	166, 22.0%	2.94 ± 2.06		
Gender				
Female	310, 41.0%	3.22 ± 2.09	2.820	0.005
Male	446, 59.0%	2.78 ± 2.14		
Marital status				
Unmarried	685, 90.6%	2.93 ± 2.12	– 1.285	0.199
Married	71, 9.4%	3.27 ± 2.16		
Religion				
Muslim	676, 89.4%	2.98 ± 2.14	0.930	0.353
Hindu	80, 10.6%	2.75 ± 1.99		
Educational status				
Up to secondary	151, 20.0%	3.01 ± 2.37	0.307	0.759
More than secondary	605, 80.0%	2.95 ± 2.06		
Socio-economic status				
Lower class	189, 25.0%	2.56 ± 1.97	4.804	0.008
Middle class	237, 31.3%	3.13 ± 2.10		
Higher class	270, 35.7%	3.11 ± 2.24		
Occupation				
Student	625, 82.7%	2.94 ± 2.150	– 0.514	0.608
Non-student	131, 17.3%	3.05 ± 2.01		
Current residence				
Rural	266, 35.2%	2.59 ± 1.98	– 3.503	<0.001
Urban	490, 64.8%	3.16 ± 2.18		
Behavior and health-related Questions				
Smoking status				
Yes	92, 12.2%	3.40 ± 2.24	2.138	0.033
No	664, 87.8%	2.90 ± 2.10		
Drug use				
Yes	14, 1.9%	2.71 ± 2.23	– 0.434	0.664
No	742, 98.1%	2.96 ± 2.13		
Physical exercise				
Yes	348, 46.0%	2.69 ± 2.03	– 3.272	0.001
No	408, 54.0%	3.19 ± 2.18		
Perceived health status				
Very good	117, 15.5%	1.85 ± 1.98	27.454	<0.001
Good	425, 56.2%	2.75 ± 1.97		
Neither good nor bad	184, 24.3%	3.80 ± 1.98		
Bad	27, 3.6%	5.26 ± 2.347		
Very bad	3, 0.4%	3.00 ± 1.73		
Comorbidity status				
Yes	206, 27.2%	3.46 ± 2.24	3.974	<0.001
No	550, 72.8%	2.77 ± 2.05		

Table 1 (Continued)

Variables	Total sample N, %	Insomnia		
		Mean and SD	F/t test value	p value
COVID Risk-related Variables				
Personal COVID-19 infection				
No	711, 94.0%	2.94 ± 2.12	– 1.146	0.252
Yes	45, 6.0%	3.31 ± 2.18		
Friend and family COVID-19 infection				
No	432, 57.1%	2.70 ± 2.03	– 3.846	<0.001
Yes	324, 42.9%	3.30 ± 2.21		
Friend and family COVID-19 death				
No	659, 87.2%	2.89 ± 2.13	– 2.152	0.032
Yes	97, 12.8%	3.39 ± 2.08		
Mental Health Problems				
Depression				
No	491, 64.9%	2.57 ± 1.94	– 6.981	<0.001
Yes	265, 35.1%	3.67 ± 2.27		
Anxiety				
No	574, 75.9%	2.52 ± 1.92	– 10.804	<0.001
Yes	182, 24.1%	4.34 ± 2.17		
Suicidality				
No	694, 91.8%	2.80 ± 2.05	– 6.977	<0.001
Yes	62, 8.2%	4.71 ± 2.22		

of insomnia. The first model includes only sociodemographic variables, whereas a 2.3% variance of insomnia was explained. While adding behavioral and health-related variables with socio-demographics in model 2, the explanatory power of insomnia increased to 15.3%. In model 3, a total of 18.3% variance of insomnia was predicted. But after adjusting with mental health issues in the final model, the explanatory power of insomnia increased by 12.9% from model 3. However, all of the models were statistically significant.

3 Discussion

People with insomnia are reported to be at an increased risk of morbidity and mortality related to cardiometabolic and neurocognitive conditions, whereas the likelihood of such a risk can be eradicated by changing sleeping habits [1]. Furthermore, during the COVID-19 pandemic, people are reportedly suffering from mental health problems like insomnia, which highlights the importance of adequate studies to adopt any policy actions [26, 27]. This is the

Table 2 Correlation coefficients between the continuous variables and insomnia

Variables	Mean and SD	1	2	3	4	5	6	7	8	9
Insomnia (1)	2.96 ± 2.13	1								
Age (2)	22.24 ± 4.39	0.020	1							
Income (3)	41,851.04 ± 82,303.58	0.012	0.059	1						
Total comorbidities (4)	0.29 ± 0.50	0.159**	0.200**	0.032	1					
COVID-19 risk (5)	0.62 ± 0.76	0.137**	0.101**	0.169**	0.037	1				
Fear of COVID-19 (6)	17.63 ± 5.88	0.212**	0.012	– 0.016	0.008	0.082*	1			
Depression (7)	2.15 ± 1.19	0.292**	– 0.028	0.014	0.083*	0.108**	0.183**	1		
Anxiety (8)	1.78 ± 1.52	0.475**	– 0.076*	0.046	0.137**	0.159**	0.322**	0.560**	1	
Suicidality (9)	1.57 ± 0.91	0.297**	0.007	0.033	0.091*	0.136**	0.143**	0.246**	0.349**	1

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Table 3 Predictive models for the insomnia

Variable	Model 1 [R ² = 0.023, F = 2.044, adjusted R ² = 0.012, p = 0.039]			Model 2 [R ² = 0.153, F = 9.449, adjusted R ² = 0.136, p < 0.001]			Model 3 [R ² = 0.183, F = 10.174, adjusted R ² = 0.165, p < 0.001]			Model 4 [R ² = 0.312, F = 17.052, adjusted R ² = 0.294, p < 0.001]		
	B	S.E	β	B	S.E	β	B	S.E	β	B	S.E	β
Constant	2.802	.755		.549	1.379		.155	1.362		-.725	1.266	
Age	.000	.024	.001	-.013	.022	-.027	-.020	.022	-.041	.001	.020	.002
Gender ^a	-.332	.168	-.076	-.131	.169	-.030	-.017	.169	-.004	.134	.157	.031
Marital status ^b	.270	.327	.038	.135	.306	.019	.210	.302	.029	.013	.278	.002
Religion ^c	-.298	.259	-.044	-.291	.244	-.042	-.408	.242	-.060	-.361	.223	-.053
Education level ^d	-.066	.205	-.012	.038	.192	.007	.035	.189	.007	.135	.174	.025
Income	<0.001	.000	.000	<0.001	.000	-.014	<0.001	.000	-.020	<0.001	.000	-.028
Residence ^e	.449	.171	.100	.423	.161	.094	.352	.162	.079	.370	.149	.083
Occupation ^f	.079	.262	.014	.116	.246	.021	.081	.242	.014	.238	.223	.042
Health status				.923	.110	.316	.825	.110	.282	.524	.105	.179
Multi comorbidities				.328	.155	.079	.364	.152	.087	.200	.141	.048
Smoking status ^g				-.709	.253	-.110	-.731	.249	-.114	-.643	.230	-.100
Drug use ^g				.578	.575	.038	.386	.568	.025	.470	.530	.031
Physical exercise ^g				.180	.155	.042	.202	.152	.047	-.012	.141	-.003
COVID-19 risk							.213	.103	.075	.034	.097	.012
Fear of COVID-19							.059	.013	.162	.022	.013	.061
Depression										.039	.070	.022
Anxiety										.481	.061	.342
Suicidality										.300	.081	.130

^a 1 = Female, 2 = Male
^b 1 = Unmarried, 2 = Married
^c 1 = Muslim, 2 = Hindu
^d 1 = Up to secondary, 2 = More than secondary
^e 1 = Rural, 2 = Urban
^f 1 = Students, 0 = Non-students
^g 1 = Yes, 2 = No.

first study assessing insomnia during the second wave of the COVID-19 pandemic in Bangladesh, which may help provide a comparative understanding of insomnia with the studies conducted during the first wave.

After the COVID-19 outbreak inception, the prevalence of insomnia is increasingly observed [26]. Ranging from 2.3 to 76.6%, with a pooled prevalence of 35.7%, insomnia is identified by a systematic review of a total of 78 studies [28], whereas the rate is found to be within 18–46.3% in Bangladesh [9]. The largest population-based study of the country reported 30.4%, 13.1%, and 2.8% rates of sub-threshold, moderate, and severe forms of insomnia, respectively, where the overall insomniac problem was 36.4% in that study [18]. However, a 13% prevalence of insomnia is found in this study, which is definitely lower than the prior studies. This may be because of issues like the difference of the insomnia assessment tool and cutoff scores, along with the previous study implementation time being the first wave of the pandemic. People are likely to adapt to the stressful pandemic situation, which may help in reducing the risk of mental health problems. Although the prevalence of insomnia reported herein is lower than the first wave studies, this figure is not neglectable. Thus, the identified associated factors are highly suggested to consider in policy actions with a special focus on mental health problems to elevate the risk of sleep problems.

In respect to gender-based insomnia suffering, female participants are reported at higher risk in this study, which is similar to the prior Bangladeshi studies conducted in the periods of normal [29, 30] or pandemic [15, 17–19]. Generally, females are highly prone to mental health suffering, a finding that is also consistent with the pandemic-related Bangladeshi studies [7, 8]. In addition, the female gender is being reported to have higher knowledge and fear of COVID-19 [31–33], which can be the risk predictors of such a situation because other studies reported COVID-19 fear increasing sleep problems [18]. Also, participants reporting higher COVID-19 risk in this study are prone to be insomniacs. The fear of COVID-19 is being reported as one of the leading suicide stressors in Bangladesh, where the risk of mental health problems such as insomnia can be easily explained [18, 19]. However, participants of this study residing in rural areas and belonging to a lower socio-economic class are at lower risk of insomnia. But, there was no significant difference in insomnia risk of the participants regarding their other sociodemographic variables (e.g., marital status, education level), which is contradictory findings with the prior Bangladeshi studies [15, 18].

Of the behavioral-related variables, being a smoker and not performing physical exercise increase the risk of insomnia. In addition, insomnia is associated with a higher level of physical health conditions as per this study findings

and reported elsewhere [18]. Similarly, people with mental health problems like depression, anxiety, suicidality etc., are found as insomniac herein; but none of the prior studies examined the role of suicidality in insomnia [14, 15, 17]. However, the role of these mental health problems in predicting insomnia explanatory power is reported as 12.9%, where other variables (socio-demographics, behavior- and health-related variables, and COVID-19 fear and risk) combinedly explained a total of 18.3% variance of insomnia. Therefore, this study suggests that people with mental health problems should be given priority while implementing any support programs.

The present study has some limitations to be noted. First of all, the survey was carried out online with a snowball approach of self-reporting data collection, which hinders the sample from being representative (i.e., most participants belonged to educated young adult age groups). The nature of this study being cross-sectional may limit establishing the causal relationships. Other issues like memory recall bias and social desirability bias may have affected the study findings. Besides, a single question on 30 min of exercise daily without consideration to the type of exercise, the severity of exercise, and the number of days in a week was used in this study, which may be a weak and insensitive indicator of physical activity. Despite these limitations, this study provides some of the baseline information related to insomnia during the second wave of the pandemic.

4 Concluding Remarks

This study is the first approach to assessing sleep problems during the second wave of the COVID-19 pandemic in Bangladesh. The prevalence of insomnia is relatively lower in this study, but this figure is not neglectable. For reducing sleep-related problems, the identified associated factors are highly suggested to consider in policy actions with a special focus on mental health problems.

Acknowledgements This is the debut publication of the first three authors (Mahmudul Hasan, Zeba Maliha, and Abidur Rahman). We are grateful to the team member of the CHINTA Research Bangladesh, for their support in implementing this project.

Funding The present study did not get any financial supports.

Data Availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The authors of the research work do not have any conflict of interest.

Ethics Approval An IRB approval was granted by the Institute of Allergy and Clinical Immunology of Bangladesh, Savar, Dhaka, Bangladesh, for conducting the study (Reference: IRBIACIB/CEC/03202032).

Consent to Participate An online consent form was required for participating in the study.

References

1. Fernandez-Mendoza J, Vgontzas AN. Insomnia and its impact on physical and mental health. *Curr Psychiatry Rep.* 2013;15:418. <https://doi.org/10.1007/s11920-013-0418-8>.
2. Holst SC, Landolt H-P. Sleep homeostasis, metabolism, and adenosine. *Curr Sleep Med Rep.* 2015;1:27–37. <https://doi.org/10.1007/s40675-014-0007-3>.
3. Kalmbach DA, Pillai V, Drake CL. Nocturnal insomnia symptoms and stress-induced cognitive intrusions in risk for depression: a 2-year prospective study. *PLoS ONE.* 2018;13: e0192088. <https://doi.org/10.1371/journal.pone.0192088>.
4. Roth T. Insomnia: definition, prevalence, etiology, and consequences. *J Clin Sleep Med.* 2007;3:S7–10. <https://doi.org/10.5664/jcsm.26929>.
5. Nagai M, Hoshida S, Kario K. Sleep duration as a risk factor for cardiovascular disease—a review of the recent literature. *Curr Cardiol Rev.* 2010;6:54–61. <https://doi.org/10.2174/157340310790231635>.
6. Anwar S, Nasrullah M, Hosen MJ. COVID-19 and Bangladesh: challenges and how to address them. *Front Public Health.* 2020;8:154. <https://doi.org/10.3389/fpubh.2020.00154>.
7. Mamun MA. Suicide and suicidal behaviors in the context of COVID-19 pandemic in Bangladesh: a systematic review. *Psychol Res Behav Manag.* 2021;14:695–704. <https://doi.org/10.2147/PRBM.S315760>.
8. al Mamun F, Hosen I, Misti JM, Kaggwa MM, Mamun MA. Mental disorders of Bangladeshi students during the COVID-19 pandemic: a systematic review. *Psychol Res Behav Manag.* 2021;14:645–54. <https://doi.org/10.2147/PRBM.S315961>.
9. Mamun MA, Hosen I, al Mamun F, Kaggwa, MM, Gozal D. Prevalence and risk factors of sleep problems in Bangladesh during the COVID-19 pandemic: a systematic review. 2021 (under review).
10. Medic G, Wille M, Hemels ME. Short- and long-term health consequences of sleep disruption. *Nat Sci Sleep.* 2017;9:151–61. <https://doi.org/10.2147/NSS.S134864>.
11. Mamun MA, Sakib N, Gozal D, Bhuiyan AKMI, Hossain S, Bodrud-Doza M, al Mamun F, Hosen I, Safiq MB, et al. The COVID-19 pandemic and serious psychological consequences in Bangladesh: a population-based nationwide study. *J Affect Disord.* 2021;279:462–72. <https://doi.org/10.1016/j.jad.2020.10.036>.
12. Ibarra-Coronado EG, Pantaleón-Martínez AM, Velazquez-Moctezuma J, Prospéro-García O, Méndez-Díaz M, Pérez-Tapia M, Pavón L, Morales-Montor J. The bidirectional relationship between sleep and immunity against infections. *J Immunol Res.* 2015;2015: 678164. <https://doi.org/10.1155/2015/678164>.
13. Gupta R, Pandi-Perumal SR. SARS-CoV-2 infection: paving way for sleep disorders in long term! *Sleep Vigil.* 2021. <https://doi.org/10.1007/s41782-021-00145-5> (Epub ahead of print).
14. Das R, Hasan MR, Daria S, Islam MR. Impact of COVID-19 pandemic on mental health among general Bangladeshi population: a cross-sectional study. *BMJ Open.* 2021;11: e045727. <https://doi.org/10.1136/bmjopen-2020-045727>.

15. Ara T, Rahman M, Hossain M, Ahmed A. Identifying the associated risk factors of sleep disturbance during the COVID-19 lockdown in Bangladesh: a web-based survey. *Front Psychiatry*. 2020;11: 580268. <https://doi.org/10.3389/fpsy.2020.580268>.
16. Barua L, Zaman MS, Omi FR, Faruque M. Psychological burden of the COVID-19 pandemic and its associated factors among frontline doctors of Bangladesh: a cross-sectional study. *F1000Research*. 2020;9:1304. <https://doi.org/10.12688/f1000research.27189.2>.
17. Ali M, Uddin Z, Ahsan NF, Haque MZ, Bairagee M, Khan SA, Hossain A. Prevalence of mental health symptoms and its effect on insomnia among healthcare workers who attended hospitals during COVID-19 pandemic: a survey in Dhaka city. *Heliyon*. 2021;7: e06985. <https://doi.org/10.1016/j.heliyon.2021.e06985>.
18. al Mamun F, Gozal D, Hosen I, Misti JM, Mamun MA. Predictive factors of insomnia during the COVID-19 pandemic in Bangladesh: a GIS-based nationwide distribution. *Sleep Med*. 2021. <https://doi.org/10.1016/j.sleep.2021.04.025> (**Epub ahead of print**).
19. Shovo TEA, Ahammed B, Khan B, Jahan N, Shohel TA, Hossain T, Islam N. Determinants of generalized anxiety, depression, and subjective sleep quality among university students during COVID-19 pandemic in Bangladesh. *Dr Sulaiman Al Habib Med J*. 2021;3:27–35. <https://doi.org/10.2991/dsahmj.k.210108.001>.
20. Mamun MA, Misti JM, Hosen I, al Mamun F. Suicidal behaviors and university entrance test-related factors: a Bangladeshi exploratory study. *Perspect Psychiatr Care*. 2021. <https://doi.org/10.1111/ppc.12783> (**Epub ahead of print**).
21. Ahorsu DK, Lin C-Y, Imani V, Saffari M, Griffiths MD, Pakpour AH. The fear of COVID-19 scale: development and initial validation. *Int J Ment Health Addict*. 2020. <https://doi.org/10.1007/s11469-020-00270-8> (**Epub ahead of print**).
22. Sakib N, Bhuiyan AKMI, Hossain S, al Mamun F, Hosen I, Abdullah AH, Sarker MA, Mohiuddin MS, Rayhan I, Hossain M, et al. Psychometric validation of the Bangla fear of COVID-19 scale: confirmatory factor analysis and rasch analysis. *Int J Ment Health Addict*. 2020. <https://doi.org/10.1007/s11469-020-00289-x> (**Epub ahead of print**).
23. Löwe B, Wahl I, Rose M, Spitzer C, Glaesmer H, Wingenfeld K, Schneider A, Brähler E. A 4-item measure of depression and anxiety: validation and standardization of the patient health questionnaire-4 (PHQ-4) in the general population. *J Affect Disord*. 2010;122:86–95. <https://doi.org/10.1016/j.jad.2009.06.019>.
24. Montgomery SA, Åsberg M. A new depression scale designed to be sensitive to change. *Br J Psychiatry*. 1979;134:382–9. <https://doi.org/10.1192/bjp.134.4.382>.
25. Kraepelien M, Blom K, Forsell E, HentatiIsacsson N, Bjurner P, Morin CM, Jernelöv S, Kaldö V. A very brief self-report scale for measuring insomnia severity using two items from the insomnia severity index—development and validation in a clinical population. *Sleep Med*. 2021;81:365–74. <https://doi.org/10.1016/j.sleep.2021.03.003>.
26. Marelli S, Castelnuovo A, Somma A, Castronovo V, Mombelli S, Bottoni D, Leitner C, Fossati A, Ferini-Strambi L. Impact of COVID-19 lockdown on sleep quality in university students and administration staff. *J Neurol*. 2021;268:8–15. <https://doi.org/10.1007/s00415-020-10056-6>.
27. Mandelkorn U, Genzer S, Choshen-Hillel S, Reiter J, Meira e Cruz M, Hochner H, Kheirandish-Gozal L, Gozal D, Gileles-Hillel A. Escalation of sleep disturbances amid the COVID-19 pandemic: a cross-sectional international study. *J Clin Sleep Med*. 2020;17:45–53. <https://doi.org/10.5664/jcsm.8800>.
28. Tasnim S, Rahman M, Pawar P, Chi X, Yu Q, Zou L, Sultana A, McKyer ELJ, Ma P, Hossain MM. Epidemiology of sleep disorders during COVID-19 pandemic: a systematic scoping review. *medRxiv*. 2020. <https://doi.org/10.1101/2020.10.08.20209148>.
29. Uzzal OK, Islam MN, Ahmed PI, Al Mamun MA, Hossain MB, Bhuiyan FK, Khan MF. Depression and insomnia in patients on maintenance hemodialysis. *J Dhaka Med Coll*. 2015;24:3–11. <https://doi.org/10.3329/jdmc.v24i1.29555>.
30. Ahmed MS, Khan S, Hsan K, Sen LC, Yunus FM, Griffiths MD. Factors affecting sleep quality among the university students in Bangladesh: a cross-sectional structured interview study. *Sleep Vigil*. 2020;4:177–84. <https://doi.org/10.1007/s41782-020-00106-4>.
31. Hossain MA, Jahid, MIK, Hossain KMA, Walton LM, Uddin Z, Haque MO, Kabir MF, Arafat SMY, Sakel M, Faruqui R, Hossain, Z. Knowledge, attitudes, and fear of COVID-19 during the rapid rise period in Bangladesh. *PLoS One*. 2020;15:e0239646. <https://doi.org/10.1371/journal.pone.0239646>.
32. Sakib N, Akter T, Zohra F, Bhuiyan AKMI, Mamun MA, Griffiths MD. Fear of COVID-19 and depression: a comparative study among the general population and healthcare professionals during covid-19 pandemic crisis in Bangladesh. *Int J Ment Health Addict*. 2021. <https://doi.org/10.1007/s11469-020-00477-9> (**Epub ahead of print**).
33. Mistry SK, Ali ARMM, Akther F, Yadav UN, Harris MF. Exploring fear of COVID-19 and its correlates among older adults in Bangladesh. *Global Health*. 2021;17:47. <https://doi.org/10.1186/s12992-021-00698-0>.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.