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Original Article

The immediate impact of the 2019 novel coronavirus (COVID-19) outbreak on subjective sleep status

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ABSTRACT

Background: An outbreak of the 2019 novel coronavirus (COVID-19) has been ongoing in China since January 2020. The threat of infection affects the work and life of most of the population and may also damage sleep. This study aims to examine the subjective sleep status and mental health of the population during the peak of the COVID-19 epidemic.

Method: The data were collected through an online questionnaire with a sample of 5461 individuals in China from February 5, 2020, to February 23, 2020. Participants were divided into four groups based on their degree of threat from COVID-19: Group 1 was most closely associated with COVID-19, including inpatients diagnosed with COVID-19, first-line hospital workers and first-line management staff; Group 2 included outpatients diagnosed with COVID-19 and patients who developed a fever and visited the hospital; Group 3 included people related to Group 1 or 2, such as their colleagues, relatives, friends and rescuers; and Group 4 was the farthest removed from contact with COVID-19, covering the general public affected by COVID-19 prevention strategies. The Insomnia Severity Index (ISI), Patient Health Questionnaire (PHQ-9), Generalized Anxiety Disorder Scale (GAD-7) and Acute Stress Disorder Scale (ASDS) were used.

Results: Threat degree of COVID-19 (groups) had significant correlations with insomnia, depression, anxiety, and stress ($p < 0.05$, $p < 0.01$). Age, gender, and area (Hubei province or other provinces) had significant correlations with insomnia ($p < 0.01$). A total of 1380 (24.46%) participants were suspected of having major depression based on the PHQ-9. Additionally, 1042 (18.47%) participants were suspected of having generalized anxiety disorder based on the GAD-7. A total of 892 (15.8%) of the participants had Acute Stress Disorder (ASD) according to the ASDS. The prevalence of clinical insomnia during the outbreak was 20.05% (1131) according to the ISI. The factors of satisfaction with the current sleep pattern and how perceptible the symptoms of the current sleep pattern are to other people ($p < 0.05$) and the middle (difficulty staying asleep) and terminal (waking up too early) ($p < 0.01$) factors of the ISI were significantly different across groups. A total of 1129 (20.01%) participants spent more than one hour awake in bed.

Conclusion: The results indicated that insomnia is more severe in people who are female, young, living in the epicenter and experiencing a high degree of threat from COVID-19. As prevention and treatment efforts continue with regard to COVID-19, the general public has developed poor sleep hygiene habits, which deserve attention.

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1. Introduction

Cases of pneumonia of unknown cause started to occur in Wuhan, China, in December 2019 [1]; these cases were later confirmed to be due to infection with a novel coronavirus, SARS-CoV-2 (COVID-19) [2]. A viral outbreak occurred in Wuhan and other cities in Hubei Province in January 2020, spreading as the population migrated to most other provinces in China [3]. As of February 10, 2020, the number of diagnosed cases of COVID-19 nationwide had reached 42,708 (31,732 in Hubei), and there had been 1017 deaths [4]. The implementation of an emergency response was announced by the Centers for Disease Control (CDC), internal and external public traffic in Wuhan city was restricted, and other provinces simultaneously implemented the highest level of emergency response to an infectious disease. People were advised to stay at home, canteens and shopping centers were closed, and public transportation (eg, buses and subways) was reduced or even stopped [5]. These measures have been effective in preventing the spread of COVID-19. Then, 10–14 days after the implementation of these measures, the daily growth of new cases of COVID-19 in most provinces declined. After more than 10,000 health care workers moved to Hubei Province to support the treatment and prevention of the disease, the epidemic situation in Wuhan and other cities in Hubei Province stabilized [6]. With the implementation of epidemic prevention and control measures, the number of infections has declined gradually, and the epidemic situation in China has become relatively stable. Nevertheless, as reported on the world health organization (WHO) website, the number of infections continues to increase globally, with more than two million confirmed cases of COVID-19 worldwide at present. Given its high morbidity and mortality, people worldwide live under the influence of the epidemic of COVID-19.

The COVID-19 outbreak occurred during the Chinese Spring Festival (January 24, 2020, to January 30, 2020) in China, which is one of the most important and longest holidays in China. Almost every Chinese citizen was forced to change plans and had to face the problem of staying at home for a long time under strict control restrictions. At the same time, the outbreak of COVID-19 caused the shortage of almost all protective supplies and fresh food due to the disruption of logistics. People received news about the infections diagnosed around them, and possible contact with infected persons was difficult to avoid. As a result, people lived in fear of SARS-CoV-2 [7].

With regard to events that may cause extreme psychological discomfort to humans, unlike natural disasters (eg, earthquakes [8–10] and floods [11]), accidents (eg, traffic accidents) [12] and major diseases (eg, tumors and acute myocardial infarction), the psychological impacts of human-to-human transmissible diseases such as Spanish influenza, severe acute respiratory syndrome (SARS) [13–16], acquired immunodeficiency syndrome (AIDS) [17,18], and Ebola [19] are long term, continuous and widespread. COVID-19 has a longer latency and is more contagious than SARS, another coronavirus-related disease [20,21]. Human-to-human transmission of SARS-CoV-2 is thought to occur mainly via respiratory droplets; the virus is released in the respiratory secretions when an infected person coughs, sneezes, or talk, which may be infectious [22–24]. SARS-CoV-2 has been reported to remain activated in aerosols for at least three hours [25], which makes it spread widely. It has been reported that asymptomatic carriers were found in several provinces in China, people can become ill 24 days after exposure, and asymptomatic carriers may also be infectious, which may increase the fear experienced by the public [4].

As defined in the DSM-V, traumatic events are actual or potential injuries that a person experiences and responds to with intense fear, helplessness or horror [26]. As a public health event, COVID-19 is a kind of traumatic event and may be an independent factor that affects sleep in the general public. Although complaints about insomnia are common, only 4%–22% of the public meet the diagnostic criteria for insomnia [27]. A meta-analysis indicated that the pooled prevalence of insomnia in China was 15.0% (95% confidence interval [CI]: 12.1%–18.5%) [28]. Sleep may therefore be a sensitive indicator of the stress status of the population. After psychological impacts such as earthquakes, wars, bombings, and attacks, the prevalence of insomnia ranges from 25 to 70% [29,30]. Trauma-induced insomnia patterns are associated with hyperarousal and more Stage 1 (N1 sleep), less slow wave sleep (N3 sleep) and increased rapid eye movement (REM) density in polysomnography [31–33]. However, studies of the sensitivity of insomnia symptoms to the intense impact of public health emergencies of international concern (PHEIC) are rare. This topic is worthy of further research.

2. Methods

2.1. Design and participants

This survey was based on an online questionnaire delivered by WeChat, a Chinese social network, from February 5, 2020, to February 23, 2020, the peak period of the COVID-19 epidemic. The deadline for submitting the questionnaire was set to one month after the restriction of internal and external traffic in Wuhan, which was the beginning of the nationwide control of transportation and crowd gathering [4]. The questionnaire was self-reported and brief because research personnel could not interview the participants during this period. The link to the questionnaire was delivered to more than 1000 hospital workers (including doctors, nurses, and medical technicians) all over China, and a snowball sampling methodology was used. Participants were invited to deliver the questionnaire to their acquaintances who were potentially interested in this survey. Each WeChat ID could submit the questionnaire only once.

A total of 17,573 individuals opened the link, and 32.10% of them completed the questionnaire and submitted their answers. Data were collected from 5641 Chinese individuals, including 1685 (29.9%) males and 3956 (70.1%) females. Participants were in all provinces of China, and 482 (8.5%) of the participants were in Hubei Province, where the COVID-19 outbreak has been the most severe. Participants ranged across all ages: 76 (1.3%) were younger than 18 years, 3995 (70.8%) were between 18 and 44 years, 1444 (25.6%) were between 45 and 60 years, and 126 (2.2%) were older than 60 years. Most of the individuals (84.2%) had 13–16 years of schooling or more (associate's, bachelor's or master's degree).

Because only anonymous data with no identifiable personal information were collected and used, prior signature of consent was waived for the participants, and we passed ethical review and were exempted by the Nanjing Hospital of Chinese Medicine from the need to obtain signature of informed consent.

2.2. Self-reported variables

We used several self-reported scales to measure our variables of interest. The Insomnia Severity Index (ISI) is a 7-item scale that measures the self-reported level of sleep quality and insomnia [34]. We used the ISI to measure the participants' nighttime and daytime insomnia components in the previous two weeks (ISI-post) and their sleep status between October and December (the last quarter) in 2019 according to their memory of it (ISI-pre) [35,36]. We used a cutoff score of 10 to judge whether a participant had clinical insomnia [37].

To measure self-reported depression and anxiety, the Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder Scale (GAD-7) were used. We used cutoff points of 5, 10, 15 and 20 to represent minimal, mild, moderate, moderately severe and severe levels of depression based on PHQ-9 scores [38,39]. GAD-7 cutoff scores of 5, 10 and 15 represented mild, moderate, and severe levels of anxiety, respectively. We used a cutoff score of 10 to determine whether a participant had major depression and a cutoff score of 10 to determine whether a participant had generalized anxiety disorder [40,41].

To measure self-reported stress, we also used the Acute Stress Disorder Scale (ASDS) [42,43]. This 19-item self-reported scale can be adapted to assess and determine acute stress disorder (ASD). This questionnaire contains 4 subscales: (1) disassociation (Questions 1–5), (2) reexperience (Questions 6–9), (3) avoidance (Questions 10–13), and (4) arousal (Questions 14–19). We determined that a participant had ASD when the score for disassociation (subscale 1) was no less than 5 and the total score on the ASDS was no less than 28 [43].

In addition, we conducted a survey on the sleep habits of the individuals, including sleep latency (choices were less than 15 min, 15–30 min, 30–60 min, more than 60 min and need hypnotic drugs), time in bed (choices were less than 5 h, 5–6 h, 6–7 h, 7–8 h, 8–9 h, 9–10 h and more than 10 h) and sleep duration (choices were less than 5 h, 5–6 h, 6–7 h, 7–8 h, 8–9 h, 9–10 h and more than 10 h) each day in the past two weeks.

2.3. Procedure

Individuals who expressed an interest in participating in the study were provided with a link through WeChat and asked to complete the online survey at their leisure. Participants were informed before they provided any information that all data collected were completely anonymous and that there would be no way to trace their responses. Participants were asked for demographic information (age, sex, degree of threat from COVID-19, etc.), and they were asked to indicate how many minutes they spent falling sleep, how many hours they spent lying in bed and how many hours they stayed asleep on average in the previous two weeks. All participants were asked to complete the ISI, PHQ-9, GAD-7, and ASDS. Participants were asked to complete the ISI a second time based on their memory of their sleep patterns between October and December 2019. The participants received brief feedback about their degree of depression, anxiety, stress and insomnia immediately upon submitting their questionnaires according to their answers to the PHQ-9, GAD-7 ASDS and ISI-post.

2.4. Statistical analysis

We stratified the participant groups according to the government standards regarding the threat of COVID-19. People affected by COVID-19 were divided into four groups: (a) Group 1 was most closely associated with COVID-19, including inpatients diagnosed with COVID-19, first-line hospital workers (doctors, nurses, medical technicians, etc.) and first-line management staff; (b) Group 2 included outpatients diagnosed with COVID-19 and patients who developed a fever and visited the hospital (who may not have been diagnosed with COVID-19); (c) Group 3 included people related to Group 1 or 2, such as their colleagues, relatives, friends and rescuers; and (d) Group 4 was the farthest removed from contact with COVID-19, covering the general public affected by COVID-19 prevention strategies.

Kruskal–Wallis nonparametric analyses were conducted to determine whether several independent groups had differences in each item on the ISI and the total ISI, PHQ-9, GAD-7, and ASDS scores. Spearman's coefficients were calculated to examine the correlations between variables [44,45]. Hierarchical regression analysis was used to measure the effects of the related factors on insomnia severity (ISI score) [46]. Analyses were conducted using SPSS version 19. The significance level was set at $p < 0.05$.

3. Results

3.1. Socio-demographics of individuals

Of the 5641 individuals, 837 (14.8%) were first-line hospital workers or first-line management staff (Group 1), 57 (1.0%) were outpatients diagnosed with COVID-19 or patients who had a fever and visited the hospital (Group 2), 660 (11.7%) individuals were colleagues, relatives, friends or rescuers related to Group 1 or 2, and 4087 (72.5%) were members of the general public affected by COVID-19 prevention strategies. The prevalence of demographic characteristics is presented in Table 1.

3.2. Depression, anxiety, stress and insomnia outcomes

The average PHQ-9 score of all participants was 6.10 ± 5.97. A total of 1380 (24.46%) participants were suspected of having major depression. The GAD-7 was used to evaluate anxiety, with an average score of 4.97 ± 5.25 points. A total of 1042 (18.47%) participants were suspected of having generalized anxiety disorder. A total of 892 (15.8%) of the participants had ASD according to the ASDS, with an average score of 27.94 ± 10.79. Among the ASDS subscales, the arousal score was the highest, with an average score of 10.00 ± 4.29, followed by disassociation (6.80 ± 2.93), avoidance (5.61 ± 2.90) and reexperience (5.53 ± 2.33) (Table 2, Table 3). The average ISI-post score of all participants was 5.93 ± 5.88, and the prevalence of clinical insomnia was 20.05% (1131) according to ISI-post. However, the ISI-pre indicated that only 14.64% (826) of individuals had clinical insomnia during the last quarter of 2019 (Table 2, Table 4).

There was a significant difference in the PHQ-9, GAD-7, and ASDS scores (disassociation, reexperiencing, avoidance, arousal and total) across groups with different degrees of threat from COVID-19. Differences between the groups are presented in Table 3. People who were farthest from the epidemic of COVID-19 (Group 4) had

Table 1
Socio-demographics of individuals.

Variables	N	%
Gender		
Male	1685	29.9
Female	3956	70.1
Age groups		
< 18	76	1.3
18–44	3995	70.8
45–60	1444	25.6
>60	126	2.2
Education		
Less than high school	308	5.5
High school or occupational certificate	581	10.3
Bachelor's or associate's degree	3411	60.5
Master's degree or above	1341	23.8
Region		
Hubei province	482	8.5
others	5159	91.5
Degree of threat from COVID-19		
Group 1	837	14.8
Group 2	57	1.0
Group 3	660	11.7
Group 4	4087	72.5

Table 2
Depression, anxiety, ASD and insomnia severity of individuals.

Variables	Level	N	%
PHQ-9	Minimal (0–4)	2813	49.9
	Mild (5–9)	1448	25.7
	Moderate (10–14)	770	13.7
	Moderately severe (15–19)	395	7.0
	Severe (20–27)	215	3.8
GAD-7	Minimal (0–4)	3310	58.7
	Mild (5–9)	1289	22.9
	Moderate (10–14)	521	9.2
	Severe (15–21)	521	9.2
ASDS	non ASD	4749	84.2
	ASD	892	15.8
ISI-post	No clinically significant insomnia (0–7)	3971	70.4
	Subthreshold insomnia (8–14)	1161	20.6
	Clinical insomnia (moderate) (15–21)	359	6.4
	Clinical insomnia (severe) (22–28)	150	2.7
ISI-pre	No clinically significant insomnia (0–7)	4295	76.1
	Subthreshold insomnia (8–14)	1026	18.2
	Clinical insomnia (moderate) (15–21)	229	4.1
	Clinical insomnia (severe) (22–28)	91	1.6

generally lower scores for each variable compared with the other three groups.

The ISI was used to compare individuals' sleep status before and after the COVID-19 outbreak. Before the event, there was no significant difference in the factor scores and total scores on the ISI among the four groups ($p > 0.05$). During the event, there was no significant difference in the factors of initial insomnia (difficulty falling asleep), interference with daily functioning or distress about current sleep problems among the four groups ($p > 0.05$). The factors of satisfaction with the current sleep pattern and how perceptible the symptoms of the current sleep pattern are to other people ($p < 0.05$), the factors of middle (difficulty staying asleep) and terminal (waking up too early) insomnia, and the total score ($p < 0.01$) were significantly different between the four groups. The outcomes and comparison of the groups are shown in Table 4.

The composition of individuals with different insomnia severities is summarized in Table 5. There were significant differences in insomnia severity by gender, age, area, threat of COVID-19 (groups), and time awake in bed. The time awake in bed was set as the difference between sleep duration and time in bed of each individual. A total of 20.01% of the participants spent more than two grades (more than one hour) awake in bed each day; for example, they spent 8–9 h in bed but slept for 6–7 h a day.

Table 3
Statistical analysis of PHQ-9, GAD-7, ASDS and ISI in groups.

Variables	G1(N = 837)	G2(N = 57)	G3(N = 660)	G4(N = 4087)	Total	H	Difference between groups					
							G1-G2	G1-G3	G1-G4	G2-G3	G2-G4	G3-G4
PHQ-9	6.52 ± 6.14	8.74 ± 7.04	6.49 ± 6.02	5.92 ± 5.90	6.10 ± 5.97	20.520**	−2.352	−0.147	2.637	2.277	3.165**	2.568
GAD-7	5.49 ± 5.37	7.51 ± 6.89	5.44 ± 5.39	4.75 ± 5.15	4.97 ± 5.25	31.126**	−1.798	0.147	3.981**	1.839	2.978*	3.418**
ASDS-Disassociation	6.96 ± 3.16	8.33 ± 4.11	6.89 ± 2.92	6.73 ± 2.86	6.80 ± 2.93	14.481**	−2.886*	−0.542	1.250	2.657*	3.317**	1.803
ASDS-Reexperiencing	5.79 ± 2.51	6.54 ± 3.37	5.80 ± 2.46	5.42 ± 2.23	5.53 ± 2.33	48.556**	−1.628	−0.496	4.815**	1.428	3.041*	4.970**
ASDS-Avoidance	5.75 ± 3.10	7.42 ± 4.31	5.84 ± 2.93	5.51 ± 2.81	5.61 ± 2.90	25.270**	−3.177**	−1.465	1.695	2.598	3.742**	3.350**
ASDS-Arousal	10.79 ± 4.73	12.16 ± 5.47	10.51 ± 4.59	9.73 ± 4.09	10.00 ± 4.29	59.897**	−1.949	1.100	4.202**	2.348	3.752**	6.156**
ASDS	29.29 ± 11.83	34.46 ± 14.75	29.05 ± 11.12	27.39 ± 10.38	27.94 ± 10.79	50.386**	−2.893*	−0.024	4.681**	2.860*	4.301**	4.264**

G1 = Group 1, G2 = Group 2, G3 = Group 3, G4 = Group 4. H, adjusted p-values (Kruskal–Wallis H Analysis) and mean ± SE for Patient Health Questionnaire (PHQ-9), Generalized Anxiety Disorder Scale (GAD-7), Acute Stress Disorder Scale (ASDS) factor scores across groups; $p < 0.05$ is indicated by *, $p < 0.01$ is indicated by **.

Table 4
Statistical analysis of insomnia severity index (ISI) factors in groups.

Variables	G1(N = 837)	G2(N = 57)	G3(N = 660)	G4(N = 4087)	Total	H	Difference between groups					
							G1-G2	G1-G3	G1-G4	G2-G3	G2-G4	G3-G4
Initial												
pre-	0.50 ± 0.79	0.56 ± 0.95	0.45 ± 0.70	0.51 ± 0.79	0.50 ± 0.78	2.513						
post-	0.63 ± 0.88	0.82 ± 1.02	0.64 ± 0.89	0.60 ± 0.88	0.61 ± 0.88	5.601						
Middle												
pre-	0.57 ± 0.82	0.65 ± 0.94	0.49 ± 0.77	0.56 ± 0.82	0.55 ± 0.82	5.726						
post-	0.80 ± 1.00	0.89 ± 1.06	0.66 ± 0.91	0.65 ± 0.91	0.67 ± 0.93	21.360**	−0.529	3.031*	4.309**	1.668	1.769	0.136
Terminal												
pre-	0.53 ± 0.79	0.65 ± 1.01	0.47 ± 0.71	0.51 ± 0.78	0.51 ± 0.77	2.027						
post-	0.75 ± 1.00	0.81 ± 1.16	0.59 ± 0.87	0.54 ± 0.84	0.58 ± 0.88	37.627**	0.267	3.028*	5.986**	0.877	1.428	1.656
Satisfaction												
pre-	1.42 ± 0.87	1.51 ± 0.89	1.37 ± 0.89	1.41 ± 0.90	1.41 ± 0.90	5.641						
post-	1.59 ± 0.97	1.70 ± 1.13	1.50 ± 1.01	1.48 ± 0.99	1.50 ± 0.99	9.255*	−0.689	1.607	2.725*	1.289	1.482	0.470
Interference												
pre-	0.71 ± 0.93	1.07 ± 1.15	0.73 ± 0.94	0.77 ± 0.98	0.76 ± 0.97	7.023						
post-	1.06 ± 1.12	1.25 ± 1.12	1.03 ± 1.09	1.01 ± 1.13	1.02 ± 1.12	5.643						
Noticeability												
pre-	0.57 ± 0.86	0.77 ± 1.05	0.57 ± 0.86	0.59 ± 0.9	0.59 ± 0.89	1.689						
post-	0.78 ± 1.01	1.00 ± 1.18	0.76 ± 0.98	0.72 ± 1.01	0.74 ± 1.01	11.046*	−1.170	0.273	2.419	1.263	1.889	1.849
Distress												
pre-	0.53 ± 0.90	0.65 ± 1.03	0.48 ± 0.83	0.54 ± 0.9	0.53 ± 0.89	1.942						
post-	0.68 ± 1.01	0.86 ± 1.14	0.63 ± 0.97	0.62 ± 0.99	0.63 ± 0.99	6.999						
Total												
pre-	4.94 ± 5.32	6.09 ± 6.57	4.63 ± 4.75	5.00 ± 5.28	4.96 ± 5.24	2.743						
Post-	6.48 ± 6.21	7.67 ± 7.42	5.94 ± 5.64	5.79 ± 5.82	5.93 ± 5.88	12.442**	−0.811	1.606	3.141**	1.410	1.725	0.847

G1 = Group 1, G2 = Group 2, G3 = Group 3, G4 = Group 4. H, adjusted p-values (Kruskal–Wallis H Analysis) and mean ± SE for pre- and post-ISI factors across groups; $p < 0.05$ is indicated by *, $p < 0.01$ is indicated by **.

4. Discussion

As a PHEIC, COVID-19 has an impact on both the physiology and psychology of humans [47]. However, due to differences in educational backgrounds, occupations and regions, individuals experience different levels of threat from COVID-19, which causes people to experience varying degrees of stress and levels of severity of insomnia. In our study, groups 1 and 2 were in direct and close contact with the virus, and groups 3 and 4 were more likely to obtain information related to the epidemic of COVID-19 from the media, social networks, friends and family members.

Obviously, acute stress anxiety and depression in individuals were directly affected by the spread of COVID-19 and changes in lifestyle. People who were more affected by the epidemic had higher ASDS, GAD-7 and PHQ-9 scores. However, the difference in anxiety and depression between groups 1, 2 and 3 was not significant, which may be related to the fact that groups 1 and 3 were mainly composed of healthcare workers. Healthcare workers have more professional knowledge of diseases, which may reduce the degree of their emotional-physical stress. At the same time, they face the psychological pressure of on-site treatment, which may increase their stress; further surveys are needed to explore these specific circumstances. Some people may develop significant anxiety and depression after experiencing acute stress, resulting in abnormal behavioral changes. Although most people respond actively to stress, abnormal behaviors associated with anxiety and depression often pose a potential risk to individuals and their communities.

Stress, anxiety and depression associated with the COVID-19 outbreak certainly cause disruptions to normal sleep patterns. The number of people with insomnia has increased significantly, and people may develop or experience relapses or worsening of frequent wakefulness during sleep, early awakening (related to hyperarousal) and even nightmares or other sleep disorders [30].

With the gradual discharge of patients treated in compartment hospitals and the lifting of restrictions in Wuhan, the national economy, transportation, and education have gradually returned to normal in China. People have generally returned to work; however, we found that many patients with short-term or relapsed insomnia come to the clinic for help. The sleep status of the participants was indirectly affected by changes caused by epidemic control measures. The sleep statuses of groups 1, 2, and 3 were strongly affected by the epidemic situation, and the factors of satisfaction with the current sleep pattern, how perceptible the symptoms are to other people, difficulty staying asleep and problems waking up too early are more sensitive indicators that require more attention.

Notably, the COVID-19 outbreak has had a substantial impact on individuals' subjective sleep quality. The experience of living through the epidemic may lead to acute insomnia in some people and may worsen symptoms in those who already have insomnia. From the perspective of the '3 P' model of insomnia [48], although this event is only a precipitating factor [49,50], whether it affects sleep is also based on the basic sleep quality and susceptibility of patients. Insomnia has a large impact on human quality of life, and early intervention is therefore needed. In addition, according to our survey, the amount of time spent in bed may be prolonged due to long stays at home; people find long periods of watching television boring, and they may read inconclusive news intended to shock readers on social media at night. A total of 20.01% of the participants suffered from more than one hour of spare time in bed. Participants in groups 2 and 4 tended to spend a much longer time in bed due to not going to work (some people work at home) and staying at home; however, groups 1 and 3 were mainly composed of healthcare workers, who had to go to work during this period and spent relatively less time in bed. From the perspective of the sleep stimulation control theory, spending spare time in bed is not conducive to healthy sleep [51,52]. There is a hidden danger of the transformation of acute insomnia into chronic insomnia, and insomnia symptoms can worsen [53]. It is necessary to disseminate sleep health education and sleep hygiene behavior interventions to the population in a timely manner. Telemedicine may be an innovative and efficient way to benefit patients with insomnia and other sleep disorders.

Because of the specific characteristics of diseases with human-to-human transmission, strict epidemic prevention and control

Table 5
Socio-demographics and sleep habits among insomnia severities.

	Non-insomnia	Subthreshold	Moderate	Severe	Total	Chi 2
N	3971 (70.4)	1161 (20.58)	359 (6.36)	150 (2.66)	5641	
Gender						
Male	1247 (31.40)	313 (26.96)	90 (25.07)	35 (23.33)	1685 (29.87)	16.156**
Female	2724 (68.60)	848 (73.04)	269 (74.93)	115 (76.67)	3956 (70.13)	
Age						
< 18	52 (1.31)	11 (0.95)	5 (1.39)	8 (5.33)	76 (1.35)	53.779**
18-44	2730 (68.75)	876 (75.45)	275 (76.60)	114 (76.00)	3995 (70.82)	
45-60	1090 (27.45)	253 (21.79)	77 (21.45)	24 (16.00)	1444 (25.60)	
> 60	99 (2.49)	21 (1.81)	2 (0.56)	4 (2.67)	126 (2.23)	
Education						
Less than high school	207 (5.21)	64 (5.51)	25 (6.96)	11 (7.33)	307 (5.44)	11.147
High school or occupational certificate	410 (10.32)	115 (9.91)	36 (10.03)	20 (13.33)	581 (10.30)	
Bachelor's or associate's degree	2377 (59.86)	724 (62.36)	216 (60.17)	94 (62.67)	3411 (60.47)	
Master's degree or above	977 (24.60)	258 (22.22)	82 (22.84)	25 (16.67)	1342 (23.79)	
Area						
Hubei Province	3675 (92.55)	1051 (90.53)	308 (85.79)	125 (83.33)	5159 (91.46)	34.716**
Other	296 (7.45)	110 (9.47)	51 (14.21)	25 (16.67)	482 (8.54)	
Threat from COVID-19						
Group 1	555 (13.98)	193 (16.62)	59 (16.43)	30 (20.00)	837 (14.84)	26.396**
Group 2	35 (0.88)	10 (0.86)	10 (2.79)	2 (1.33)	57 (1.01)	
Group 3	459 (11.56)	135 (11.63)	52 (14.48)	14 (9.33)	660 (11.70)	
Group 4	2922 (73.58)	823 (70.89)	238 (66.30)	104 (69.33)	4087 (72.45)	
Awake in bed						
Others	3406 (85.77)	806 (69.42)	212 (59.05)	88 (58.67)	4512 (79.99)	304.816**
more than at least one hour	565 (14.23)	355 (30.58)	147 (40.95)	62 (41.33)	1129 (20.01)	

Non-insomnia = no clinically significant insomnia (0–7), Subthreshold = subthreshold insomnia (8–14), Moderate = clinical insomnia (moderate) (15–21), Severe = clinical insomnia (severe) (22–28). Pearson chi 2, p-values and N (%) for socio-demographics and sleep habits across groups ($p < 0.05$ is indicated by *, $p < 0.01$ is indicated by **).

are needed. It is recommended that the general population reduce all outside and social activities, which affects exercise and eating habits. Many people choose to take naps during the day or watch television and play games on their phones in bed; they lack regular exposure to sunlight, which affects their biological rhythms. Therefore, we recommend that people open their windows and ventilate their rooms, ensure moderate exposure to sunlight, and engage in appropriate indoor exercise during the COVID-19 epidemic [54–56]. It is suggested that e-aid cognitive behavioral therapy (e-CBTI) may be a good way to improve the public's sleep health during the event [57–59].

The survey has several limitations. First, we used the ISI to evaluate symptoms of insomnia before and after the event, which may have resulted in recall bias on the ISI-pre. Second, according to the standards we used, the occupations of the participants were not considered. As a result, Group 1 was composed of mostly first-line health care workers because severely ill inpatients may not have completed the questionnaire; however, we could not separate them clearly for analysis. Finally, due to the difference in the population characteristics in the groups, the number of Group 2 participants was small, which may have affected the results.

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Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2020.05.018.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2020.05.018.

References

[1] Zhang JJ, Dong X, Cao YY, et al. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. Allergy; 2020.
[2] Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020;382:727–33.
[3] Li Q, Guan X, Wu P, et al. Early transmission dynamics in wuhan, China, of novel coronavirus–infected pneumonia. N Engl J Med 2020;382:1199–207.
[4] Special Expert Group for Control of the Epidemic of Novel Coronavirus Pneumonia of the Chinese Preventive Medicine A. An update on the epidemiological characteristics of novel coronavirus pneumoniaCOVID-19. Zhonghua Liuxingbingxue Zazhi 2020;41:139–44.
[5] Sohrabi C, Alsafi Z, O'Neill N, et al. World health organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19). Int J Surg 2020;76:71–6.
[6] Lai CC, Shih TP, Ko WC, et al. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): the epidemic and the challenges. Int J Antimicrob Agents 2020:105924.
[7] Lee A. Wuhan novel coronavirus (COVID-19): why global control is challenging? Publ Health 2020;179:A1–2.
[8] Zhang Y, Kong F, Wang L, et al. Mental health and coping styles of children and adolescent survivors one year after the 2008 Chinese earthquake. Child Youth Serv Rev 2010;32:1403–9.
[9] Trip H, Tabakakis K, Maskill V, et al. Psychological health and resilience: the impact of significant earthquake events on tertiary level professional students. A cross-sectional study. Contemp Nurse 2018;54:319–32.
[10] Lazaratou H, Paparrigopoulos T, Anomitri C, et al. Sleep problems six-months after continuous earthquake activity in a Greek island. Psychiatriki 2018;29: 25–33.
[11] Longman JM, Bennett-Levy J, Matthews V, et al. Rationale and methods for a cross-sectional study of mental health and wellbeing following river flooding in rural Australia, using a community-academic partnership approach. BMC Publ Health 2019;19:1255.
[12] Dai W, Liu A, Kaminga AC, et al. Prevalence of acute stress disorder among road traffic accident survivors: a meta-analysis. BMC Psychiatr 2018;18:188.
[13] McAlonan GM, Lee AM, Cheung V, et al. Immediate and sustained psychological impact of an emerging infectious disease outbreak on health care workers. Can J Psychiatr 2007;52:241–7.
[14] Grace SL, Hershenfield K, Robertson E, et al. The occupational and psychosocial impact of SARS on academic physicians in three affected hospitals. Psychosomatics 2005;46:385–91.
[15] Chan AO, Huak CY. Psychological impact of the 2003 severe acute respiratory syndrome outbreak on health care workers in a medium size regional general hospital in Singapore. Occup Med (Lond) 2004;54:190–6.
[16] Tsang HW, Scudds RJ, Chan EY. Psychosocial impact of SARS. Emerg Infect Dis 2004;10:1326–7.
[17] Meng YJ, Li NX, Liu CJ, et al. Quality of life and hostile mentality trend of patients with HIV/AIDS in China. Publ Health 2008;122:404–11.
[18] Ezegbe BN, Eseadi C, Ede MO, et al. Rational emotive digital storytelling therapy for improving HIV/AIDS knowledge and risk perception among schoolchildren: a group randomized trial. J Ration Emot Cogn Behav Ther 2019;37:358–74.
[19] Thomas SP. Ebola and mental health. Issues Ment Health Nurs 2015;36: 247–8.
[20] Jin YH, Cai L, Cheng ZS, et al. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). Mil Med Res 2020;7:4.
[21] Stockman LJ, Bellamy R, Garner P. SARS: systematic review of treatment effects. PLoS Med 2006;3:e343.
[22] Hoehl S, Berger A, Kortenbusch M, et al. Evidence of SARS-CoV-2 infection in returning travelers from wuhan, China. N Engl J Med 2020;382:1278–80.
[23] Li X, Zai J, Zhao Q, et al. Evolutionary history, potential intermediate animal host, and cross-species analyses of SARS-CoV-2. J Med Virol 2020. https://doi.org/10.1002/jmv.25731. Online ahead of print. PMID: 32104911 PMCID: PMC7228310.
[24] Zou L, Ruan F, Huang M, et al. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. N Engl J Med 2020;382:1177–9.
[25] van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med 2020;382: 1564–7.
[26] Association AP. Diagnostic and statistical manual of mental disorder. 5 ed. Arlington, VA: American Psychiatric Publishing; 2015.
[27] Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn. Sleep Med Rev 2002;6:97–111.
[28] Cao XL, Wang SB, Zhong BL, et al. The prevalence of insomnia in the general population in China: a meta-analysis. PloS One 2017;12:e0170772.
[29] Short NA, Raines AM, Oglesby ME, et al. Insomnia and emotion dysregulation: independent and interactive associations with posttraumatic stress symptoms among trauma-exposed smokers. J Affect Disord 2014;165:159–65.
[30] Sinha SS. Trauma-induced insomnia: a novel model for trauma and sleep research. Sleep Med Rev 2016;25:74–83.
[31] Moldofsky H, Rothman L, Kleinman R, et al. Disturbed EEG sleep, paranoid cognition and somatic symptoms identify veterans with post-traumatic stress disorder. BJPsych Open 2016;2:359–65.
[32] Spoormaker VI, Montgomery P. Disturbed sleep in post-traumatic stress disorder: secondary symptom or core feature? Sleep Med Rev 2008;12: 169–84.
[33] Kobayashi I, Boarts JM, Delahanty DL. Polysomnographically measured sleep abnormalities in PTSD: a meta-analytic review. Psychophysiology 2007;44: 660–9.
[34] Morin CM, Belleville G, Belanger L, et al. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. Sleep 2011;34:601–8.
[35] Bastien C. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. Sleep Med 2001;2:297–307.
[36] Gagnon C, Belanger L, Ivers H, et al. Validation of the insomnia severity index in primary care. J Am Board Fam Med 2013;26:701–10.
[37] Albougami A, Manzar MD. Insomnia severity index: a psychometric investigation among Saudi nurses. Sleep Breath 2019;23:987–96.
[38] Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med 2001;16:606–13.
[39] Arrieta J, Aguerrebere M, Raviola G, et al. Validity and utility of the patient health questionnaire (PHQ)-2 and PHQ-9 for screening and diagnosis of depression in rural chiapas, Mexico: a cross-sectional study. J Clin Psychol 2017;73:1076–90.
[40] Seo J-G, Park S-P. Validation of the generalized anxiety disorder-7 (GAD-7) and GAD-2 in patients with migraine. J Headache Pain 2015;16.
[41] Kertz S, Bigda-Peyton J, Bjorgvinsson T. Validity of the Generalized Anxiety Disorder-7 scale in an acute psychiatric sample. Clin Psychol Psychother 2013;20:456–64.
[42] Zhou P, Zhang Y, Wei C, et al. Acute stress disorder as a predictor of post-traumatic stress: a longitudinal study of Chinese children exposed to the Lushan earthquake. PsyCh J 2016;5:206–14.

[43] Bryant RA, Moulds ML, Guthrie RM. Acute Stress Disorder Scale: a self-report measure of acute stress disorder. Psychol Assess 2000;12:61–8.
[44] Hauke JKT. Comparison of values of pearson's and spearman's correlation coefficients on the same sets of data. Quaest Geogr 2011;30:87–93.
[45] Arndt STC, Andreasen NC. Correlating and predicting psychiatric symptom ratings: spearmans r versus Kendalls tau correlation. J Psychiatr Res 1999;33:97–104.
[46] Dao-de S. Selection of the linear regression model according to the parameter estimation. Wuhan Univ J Nat Sci 2000;5:400–5.
[47] Hall Brown TS, Akeeb A, Mellman TA. The role of trauma type in the risk for insomnia. J Clin Sleep Med 2015;11:735–9.
[48] Poluektov MG, Pchelina PV. Chronic insomnia: treatment methods based on the current "3P" model of insomnia. Zh Nevrol Psikhiatr Im S S Korsakova 2015;115:141–7.
[49] Bastien CH, Vallieres A, Morin CM. Precipitating factors of insomnia. Behav Sleep Med 2004;2:50–62.
[50] Bollu PC, Kaur H. Sleep medicine: insomnia and sleep. Mo Med 2019;116:68–75.
[51] Sleep restriction therapy and hypnotic withdrawal versus sleep hygiene education in hypnotic using patients with insomnia. 2010.
[52] Spielman AJSP, Thorpy MJ. Treatment of chronic insomnia by restriction of time in bed. Sleep 1987;10(1):45–56.
[53] Morin CM, Bootzin RR, Buysse DJ, et al. Psychological and behavioral treatment of insomnia:update of the recent evidence (1998-2004). Sleep 2006;29:1398–414.
[54] Hood HK, Rogojanski J, Moss TG. Cognitive-behavioral therapy for chronic insomnia. Curr Treat Options Neurol 2014;16:321.
[55] Rossman J. Cognitive-behavioral therapy for insomnia: an effective and underutilized treatment for insomnia. Am J Lifestyle Med 2019;13:544–7.
[56] Wu R, Bao J, Zhang C, et al. Comparison of sleep condition and sleep-related psychological activity after cognitive-behavior and pharmacological therapy for chronic insomnia. Psychother Psychosom 2006;75:220–8.
[57] Solomon D, Proudfoot J, Clarke J, et al. E-CBT (myCompass), antidepressant medication, and face-to-face psychological treatment for depression in Australia: a cost-effectiveness comparison. J Med Internet Res 2015;17:e255.
[58] Koffel E, Kuhn E, Petsoulis N, et al. A randomized controlled pilot study of CBT-I Coach: feasibility, acceptability, and potential impact of a mobile phone application for patients in cognitive behavioral therapy for insomnia. Health Inf J 2018;24:3–13.
[59] Matthews EE, Schmiege SJ, Cook PF, et al. Adherence to cognitive behavioral therapy for insomnia (CBTI) among women following primary breast cancer treatment: a pilot study. Behav Sleep Med 2012;10:217–29.