Sleep disturbance and anxiety symptom among public during the second wave of COVID-19 in Beijing: A web-based cross-sectional survey

Yanan Liu [a], Xi Wang [a], Pengfei Sun [b], Qi Zhang [a], Cheng Zhang [a], Yane Shen [a], Shixuan Wang [a], Jing Ma [a,*], Guangfa Wang [a]

[a] *Department of Pulmonary and critical care medicine, Peking University First Hospital, Beijing, China*
[b] *Department of Cardiology, Peking University First Hospital, Beijing, China*

A B S T R A C T

Purpose: The global coronavirus disease 2019 (COVID-19) epidemic has significantly impacted people's lives. This study aimed to examine the influence of the unexpected second wave of COVID-19 on sleep quality and anxiety of Chinese residents in Beijing in June 2020, compared with the initial outbreak at the beginning of 2020, and to investigate the associated factors.
Methods: Using a web-based cross-sectional survey, we collected data from 1,511 participants. assessed with demographic information, sleep quality and anxiety symptoms. The participants were asked to compare their recent sleep and sleep during the first outbreak. The Zung's Self-rating Anxiety Scale (SAS) was used to assess their current insomnia severity. Multivariable logistic regression models were used to analyze the association between COVID-19 epidemic and risk of sleep disturbance and anxiety symptom.
Results: The overall prevalence of sleep disturbance and anxiety symptoms were 50.8% and 15.3% respectively. People had significantly shorter sleep duration during the second wave of COVID-19(7.3 ± 1.3) h than the first outbreak (7.5 ± 1.4)h ($p < 0.001$). During the second outbreak, people were less concerned about infection and more concerned about financial stress and occupational inference. Beijing residents did not have significant differences in sleep disturbance and anxiety compared with other regions, nor were occupations and nucleic acid testing associated risk factors. Home quarantine, health administrators, history of insomnia and anxiety-depression were significantly associated with sleep disturbance. Female gender, home quarantine, history of insomnia and anxiety-depression were significantly associated with anxiety.
Conclusion: High prevalence of sleep disturbance and depression symptom was common during the second wave of COVID-19 crisis in Beijing. Home quarantine and previous history of insomnia and anxiety-depressive risk factors were associated with sleep disturbance and anxiety. Female gender was impacting predictor of anxiety. We need continuous assessment of the sleep quality and anxiety symptoms of this epidemic.

1. Introduction

The Covid-19 outbreak has so far become the greatest and most widespread public health event in this century (World Health Organization, 2020). The outbreak has spread over 100 countries, with over 100 million confirmed cases and more than 2 millon deaths attributable to this disease reported worldwide (Worldometers, 2020).

With all efforts directed towards fighting COVID-19, the pandemic was largely brought under control in China by mid- April. However, Beijing's confirmation of a COVID-19 case on 11 June ended its 55-day streak without reported local transmission. The number of confirmed

cases exceeded 100 in just five days, forcing the government to step up emergency footing as the virus flared up again in Beijing by implementing the most stringent control measures, from mass nucleic acid testing, home quarantine to city lockdowns. The second wave of COVID-19 in Beijing generated new pressure on people's daily lives, health, economic well-being and social interactions.

According to previous studies about the public health emergency, anxiety, depression and stress levels in the general population could increase and these negative emotions would have an influence on sleep quality (Hamza Shuja et al., 2020).Currently, many studies and surveys have reported sleep disturbance and other negative psychological

impacts of epidemic (Tian et al., 2020). COVID-19 challenges continue across the world, but there is still a lack of relevant research about sleep and mood fluctuations after exposure to repeated epidemics. Therefore a web-based cross-sectional survey was conducted to assess the impacts of the COVID-19 outbreak on sleep and mental health to explore the factors associated with sleep disturbance and anxiety syndrome. This research will help healthcare professionals and policy makers to make targeted intervention strategies for the public's sleep and psychological problems during the COVID-19 outbreak, and offer further support for the work resumption and related public policies.

2. Materials and methods

2.1. Setting and participants

Participants answered the questionnaires anonymously online from 22 June 2020 to 26 June 2020. This web-based survey of sleep quality and anxiety due to COVID-19 was distributed on the Internet through the WeChat public platform. Chinese residents were invited to answer the questionnaire by scanning the Quick Response code (QR code). The questionnaire is set on an online crowdsourcing platform in mainland China. When the participants click on the link, they are taken to an electronic form, starting with a description of study objectives, consent to participation and other ethical points. This web-based questionnaire was completely voluntary and non-commercial.

2.2. Tools and techniques

This study used a self-administered Chinese questionnaire to collect data. The questionnaire consisted of 34 structured, closed-ended questions. The questionnaire was divided into three domains: socio-demographics, self-reported sleep questionnaire, and Zung (1965) Self-rating Anxiety Scale (SAS). The details of self-reported sleep questionnaire are provided as supplemental data (Tables S1–S4). In order to ensure the quality of the survey, all questions were compulsory except for seven questions pertaining only to healthcare workers. Based on a pilot test, the research team estimated that it would take each participant around 2.5 to 10 min to complete the questionnaire. Questionnaires that were completed < 150 s were excluded from the analysis.

2.3. Variables

All subjects reported their demographic data and COVID-19 related information. Demographic variables included gender (male or female), age, occupation, education level and residential location. Healthcare professionals including nurses, physicians, administrative staff, physicians in trainee, technicians, pharmacist, laboratory staff, radiology department technician etc. Based on the self-administered surveys, sleep disturbance levels were grouped as normal, mild-moderate, severe, or extreme. Levels of anxiety were assessed using Zung's Self-rating Anxiety Scale (SAS), which is widely used for adult subjects, including an anxiety level rating questionnaire based on the symptoms of anxiety disorders as described in the Diagnostic and Statistical Manual of Mental Disorders (DSM-II). SAS scale is short self-administered surveys, each with 20 questions scored on a 4-point Likert scale subsequently multiplied by 1.25 for a guaranteed score. There was a positive correlation between the anxiety score and the anxiety tendency, and the critical value was a standard score of 50. Scores ranging from 50 to 59 correspond to low anxiety, scores ranging from 60 to 69 correspond to moderate anxiety, while scores over 69 correspond to high perceived anxiety.

2.4. Statistical analysis

All statistical analyses were performed using R software (version 3.6.3, http://www.R-project.org). Continuous variables were summarized by descriptive analysis, reported as arithmetic mean (x) and standard deviation (SD). The differences in population characteristics were compared using *t* test, Man-Whitney U test or Pearson chi-squared test, accordingly. Univariate logistic regression with crude odds ratios (OR) was used to identify potential factors associated with sleep disturbance and anxiety. Covariates adjusted in the models included sex, age, educational attainment, occupation, region, psychological and sleeping disorder history and underlying disease. Variables that were significant predictors ($p < 0.05$) in the univariate analysis would be considered in the multivariate analysis. The identified covariates were presented in terms of Odds Ratios (ORs) and 95% confidence intervals (95% CI). For all comparisons, differences were tested using two-tailed tests and $p < 0.05$ was considered to be statistically significant.

2.5. Ethical consideration

The Research Ethics Committee (REC) of the Healthcare Research Committee, Peking University First Hospital, approved the research. As participation was voluntary and survey responses were anonymous, the REC ruled that this study did not require informed consent. No incentive or reward was given for study participation. This study was approved by the institutional review board of the committee of Peking University First Hospital. We performed all procedures following the guidelines of our institutional ethics committee and adhered to the tenets of the Declaration of Helsinki.

3. Results

3.1. Sample characteristics

Characteristics of participants are presented in Table 1. The current study collected 1622 questionnaires, and after exclusion of questionnaires completed in under 150 s, enrolled 1511 participants who provided usable responses, with a response rate of 93.2%, including 449 (29.7%) males and 1062(70.3%) females. More than three quarters of the participants were young or middle-aged residents. 1192(78.9%) were under 45 years old and 1465(96.9%) participants had a bachelor's or higher degree. Among these samples, 1195(79.1%) were residents in Beijing, 669 (44.3%) of participants were healthcare workers. 95 (6.3%) participants reported home quarantine during the survey period. 793 (52.5%) participants were subjected to a nasopharyngeal swab for coronavirus.

3.2. Prevalence of sleep disturbance and anxiety

The overall prevalence of sleep disturbance and anxiety was 50.8% and 15.3%, respectively (Table 1). There was no statistically significant difference in the prevalence of sleep disturbance and anxiety by occupation, region and underlying disease. Women had a significantly higher prevalence of anxiety than men ($p = 0.004$). There was a significant difference in sleep disturbance between different groups of educational levels ($p = 0.005$). Compared with other health groups, patients with a history of insomnia and anxiety-depression reported a higher rate of poor sleep quality and anxiety during the fresh outbreak of COVID-19 ($p < 0.001$). Habitual snorers had a higher risk of sleep disturbance than others ($p < 0.001$).

And more notably, in the current study, only 80 (5.29%) participants suffered from a more severe form of sleep disturbance than the first outbreak, including waking up early, nighttime awakenings and insomnia. Meanwhile only 156 (10.3%) participants reported more severe anxiety.

3.3. Comparison of sleep time

Sleep duration in the second wave in Beijing was shorter than that in the first outbreak (7.5 h $\pm$ 1.4 h vs. 7.3 h $\pm$ 1.3 h, $p < 0.001$). We then

Table 1
Prevalence of sleep disturbance and anxiety during COVID-19 outbreak stratified by study population characteristics (N = 1511).

Variables	Total	Sleep disturbance			Anxiety state		
		No	Yes	p-value	No	Yes	p-value
Number	1511	743(49.2)	768(50.8)		1280(84.7)	231(15.3)	
Gender				0.109			0.004*
female	1062 (70.2)	508 (68.4)	554 (72.1)		881 (68.8)	181 (78.4)	
male	449 (29.8)	235 (31.6)	214 (27.9)		399 (31.2)	50 (21.6)	
Age				0.83			0.621
≤25y	170 (11.3)	80 (10.8)	90 (11.7)		141 (11.0)	29 (12.6)	
26~35y	634 (42.0)	307 (41.3)	327 (42.6)		533 (41.6)	101 (43.7)	
36~45y	388 (25.7)	198 (26.6)	190 (24.7)		331 (25.9)	57 (24.7)	
46~55y	206 (13.6)	105 (14.1)	101 (13.2)		174 (13.6)	32 (13.9)	
≥55y	113 (7.5%)	53 (7.1)	60 (7.8)		101 (7.9)	12 (5.2)	
Region				0.938			0.561
Beijing	1195 (79.1)	587(79.0)	608 (79.2)		1009 (78.8)	186 (80.5)	
Other	316 (20.9)	15(21.0)	160(20.8)		271(21.2)	45(19.5)	
Education level				0.005*			0.059
Doctor degree	249 (16.5)	147 (19.8)	102 (13.3)		225 (17.6)	24 (10.4)	
Graduate degree	330 (21.8)	165 (22.2)	165 (21.5)		278 (21.7)	52 (22.5)	
Bachelor degree	673 (44.5)	320 (43.1)	353 (46.0)		555 (43.4)	118 (51.1)	
Associate degree	213 (14.1)	90 (12.1)	123 (16.0)		182 (14.2)	31 (13.4)	
Senior middle school or below	46(3.1)	21 (2.8)	25 (3.3)		40 (3.1)	6 (2.6)	
Occupation				0.057			0.636
Healthcare workers[a]	669 (44.3)	328 (44.1)	341 (44.4)		562 (43.9)	107 (46.3)	
Company employee	343 (22.7)	178 (24.0)	165 (21.5)		298 (23.3)	45 (19.5)	
Government officer	32 (2.1)	21 (2.8)	11 (1.4)		25 (2.0)	7 (3.0)	
Teaching staff	56 (3.7)	25 (3.4)	31 (4.0)		47 (3.7)	9 (3.9)	
Students	120 (7.9)	54 (7.3)	66 (8.6)		96 (7.5)	24 (10.4)	
Retired	62 (4.1)	36 (4.8)	26 (3.4)		55 (4.3)	7 (3.0)	
Home maker	34 (2.3)	21 (2.8)	13 (1.7)		29 (2.3)	5 (2.2)	
liberal professions	53 (3.5)	22 (3.0)	31 (4.0)		47 (3.7)	6 (2.6)	
Tourism and other[b]	142 (9.4)	58 (7.8)	84 (10.9)		121 (9.5)	21 (9.1)	
Psychological and sleeping disorder							
Insomnia	214 (14.2)	62 (8.3)	152 (19.8)	<0.001*	150 (11.7)	64 (27.7)	<0.001*
Anxiety-depression	193 (12.8)	53 (7.1)	140 (18.2)	<0.001*	114 (8.9)	79 (34.2)	<0.001*
Snoring	197 (13.0)	83 (11.2)	114 (14.8)	0.034*	158 (12.3)	39 (16.9)	0.059
Underlying disease							
Hypertension	95 (6.3)	50 (6.7)	45 (5.9)	0.486	76 (5.9)	19 (8.2)	0.187
Diabetes	33 (2.2)	15 (2.0)	18 (2.3)	0.666	27 (2.1)	6 (2.6)	0.64
Coronary heart disease	9 (0.6)	2 (0.3)	7 (0.9)	0.105	6 (0.5)	3 (1.3)	0.131
Cerebrovascular	5 (0.3)	2 (0.3)	3 (0.4)	0.681	4 (0.3)	1 (0.4)	0.769
Chronic Obstructive Pulmonary disease	14 (0.9)	7 (0.9)	7 (0.9)	0.95	11 (0.9)	3 (1.3)	0.521
Chronic Kidney disease	4 (0.3)	2 (0.3)	2 (0.3)	0.974	3 (0.2)	1 (0.4)	0.589
Cancer	15 (1.0)	9 (1.2)	6 (0.8)	0.399	11 (0.9)	4 (1.7)	0.218
Home quarantine				<0.001*			0.005*
home quarantine	95 (6.3%)	26 (3.5)	62 (8.1)		71 (5.5)	24 (10.4)	
non-home quarantine	1416(93.7)	717(96.5)	706(91.2)		1209(94.5)	107(89.6)	

Data presented as range or n (%); bold = p < 0.05.
a Included doctors, nurses and health administrators.
b Included tourism employees, drivers, restaurant employees and other relevant staff.

compared the bedtime among the participants according to the self-reported degree of sleep disturbance during the two outbreaks (Table 2). In different groups of sleep disturbance, there was significant difference of bedtime during the first outbreak (p < 0.001), but no difference during the second wave of COVID-19 (p = 0.577).

Table 3.

Table 2
Comparison of bedtime during two outbreaks of COVID-19 (n = 1511).

	Overall n = 1511	Without sleep disturbance or sleep improvement n = 743	Mild sleep disturbance n = 451	Moderate sleep disturbance n = 249	Severe sleep disturbance n = 68	p value
First wave						< 0.001*
before 11pm	393 (26.0)	232 (31.2)	95 (21.1)	56 (22.5)	10 (14.7)	
11pm-12pm	688 (45.5)	330 (44.4)	222 (49.2)	113 (45.4)	23 (33.8)	
12pm-1am	339 (22.4)	153 (20.6)	107 (23.7)	58 (23.3)	21 (30.9)	
after 1am	91 (6.0)	28 (3.8)	27 (6.0)	22 (8.8)	14 (20.6)	
Second wave						0.577
before 11pm	423 (28.0)	219 (29.5)	118 (26.2)	70 (28.1)	16 (23.5)	
11pm-12pm	644 (42.6)	312 (42.0)	206 (45.7)	98 (39.4)	28 (41.2)	
12pm-1am	336 (22.2)	166 (22.3)	95 (21.1)	57 (22.9)	18 (26.5)	
after 1am	108 (7.1)	46 (6.2)	32 (7.1)	24 (9.6)	6 (8.8)	

Data presented as range or n (%); bold = p < 0.05.

Table 3

Concerns in the second wave of COVID-19 (n = 1511).

	overall n = 1511	without sleep disturbance or sleep improvement n = 743	mild sleep disturbance n = 451	moderate sleep disturbance n = 249	severe sleep disturbance n = 68	p value
Fear of COVID-19 pandemic	325 (21.5)	22 (3.0)	152 (33.7)	120 (48.2)	31 (45.6)	< 0.001*
Travel history to high risk region, fear of infection	75 (5.0)	6 (0.8)	32 (7.1)	30 (12.0)	7 (10.3)	< 0.001*
Job stress	449 (29.7)	112 (15.1)	177 (39.2)	117 (47.0)	43 (63.2)	< 0.001*
Reduced income	320 (21.2)	73 (9.8)	120 (26.6)	96 (38.6)	31 (45.6)	< 0.001*
Children or aged persons left unattended	176 (11.6)	44 (5.9)	70 (15.5)	44 (17.7)	18 (26.5)	< 0.001*
Travel restrictions	288 (19.1)	54 (7.3)	131 (29.0)	80 (32.1)	23 (33.8)	< 0.001*
Hot weather	397 (26.3)	121 (16.3)	169 (37.5)	88 (35.3)	19 (27.9)	< 0.001*
Physical discomfort such as headache, chest tightness, etc	96 (6.4)	13 (1.7)	34 (7.5)	36 (14.5)	13 (19.1)	< 0.001*

Data presented as range or n (%); bold = p < 0.05.(Total of each column exceeds n because participants could select multiple choices.).

3.4. Self-reported COVID-19-related factors associated with sleep disturbance

Tables 3 shows the self-reported COVID-19-related factors associated with sleep disturbance. Complaints reported by the general public in order of decreasing frequency are occupational interference by COVID-19(449, 29.7%), fear of COVID-19 pandemic(325, 21.5%), reduced income(320, 21.2%), travel restrictions(288, 19.1%) and children or aged persons left unattended(176, 11.6%). Only 5% of participants had previously traveled to a high-risk epidemic region and feared infection. The differences between various sleep disorder groups are significant(p <

0.001). In the moderate and severe sleep disturbance groups, besides worrying about COVID-19 job stress and reduced income are the most important factors associated with sleep disturbance.

3.5. Predictors of sleep disturbance and anxiety symptom

Regression analyses were used to investigate the associated factors of sleep disturbance during the second COVID-19 outbreak (Table 4).

We put several potential factors into the analysis including education degree, occupation, home quarantine, a history of psychological and sleeping disorders, anxiety status scored by SAS. All the significant

Table 4

Factors associated with sleep disturbance examined by univariate logistic regression and multivariate binary logistic regression analyses (n = 1511).

Variables in the Equation	N	Univariate logistic regression				Multivariate binary logistic regression	
		No event,%	Event,%	OR (95% CI)	P value	OR (95% CI)	P value
Gender							
Female	1062	508 (47.8)	554 (52.2)	1.20(0.96,1.49)	0.11	1.07 (0.83,1.36)	0.606
Age							
≤ 25y	170	80 (47.1)	90 (52.9)	ref			
26~35y	634	307 (48.4)	327 (51.6)	0.95(0.67,1.33)	0.752	0.95 (0.66,1.37)	0.775
36~45y	388	198 (51.0)	190 (49.0)	0.85(0.59,1.22)	0.388	0.84 (0.57,1.24)	0.384
46~55y	206	105 (51.0)	101 (49.0)	0.86(0.57,1.28)	0.45	0.86 (0.55,1.34)	0.492
≥ 55y	113	53 (46.9)	60 (53.1)	1.01(0.62,1.62)	0.979	0.95 (0.56,1.62)	0.847
Education level							
Doctor and Graduate degree	579	312 (53.9)	267 (46.1)	ref			
Bachelor degree	673	320 (47.5)	353 (52.5)	1.29(1.03,1.61)	0.025*	1.00 (0.75,1.33)	0.999
Associate degree	213	90 (42.3)	123 (57.7)	1.60(1.16,2.19)	0.004*	1.27 (0.86,1.86)	0.227
Senior middle school or below	46	21 (45.7)	25 (54.3)	1.39(0.76,2.54)	0.283	1.18 (0.61,2.28)	0.628
Professional background							
Non-healthcare workers	845	417 (49.3)	428 (50.7)	ref			
Medical doctor	384	215 (56.0)	169 (44.0)	0.77(0.60,0.98)	0.031	0.87 (0.62,1.22)	0.409
Registered nurse	197	80 (40.6)	117 (59.4)	1.42(1.04,1.95)	0.027*	1.28 (0.87,1.90)	0.214
Health administrators	85	31 (36.5)	54 (63.5)	1.70(1.07,2.69)	0.025*	1.83 (1.10,3.05)	0.021*
Home quarantine							
Non-home quarantine	1423	717 (50.4)	706 (49.6)	ref			
Home quarantine	88	26(29.5)	62 (70.5)	2.42(1.51,3.87)	<0.001*	2.16 (1.32,3.55)	0.002*
Psychological and sleeping disorder							
Non-Insomnia	1297	681 (52.5)	616 (47.5)	ref			
Insomnia	214	62 (29.0)	152 (71.0)	2.71(1.98,3.71)	< 0.001*	2.03(1.43, 2.87)	< 0.001*
No Anxiety-depression	1318	690 (52.4)	628 (47.6)	ref			
Anxiety-depression	193	53 (27.5)	140 (72.5)	2.90(2.08,4.05)	< 0.001*	1.67(1.15, 2.44)	0.007*
Non-snoring	1314	660 (50.2)	654 (49.8)	ref			
Snoring	197	83 (42.1)	114 (57.9)	1.39(1.02,1.88)	0.035*	1.33 (0.95,1.86)	0.093
Anxiety state							
Non-Anxiety state	1280	694 (54.2)	586 (45.8)	ref			
Mild anxiety	200	45 (22.5)	155 (77.5)	4.08(2.88,5.79)	< 0.001*	3.28 (2.28,4.73)	< 0.001*
Moderate-severe anxiety	31	4 (12.9)	27 (87.1)	7.99(2.78,22.98)	< 0.001*	6.09 (2.06,17.98)	0.001*

CI = confidence interval; OR = crude odds ratio; bold = p < 0.05.

factors in univariate logistic regression were included in the multivariate regression model, which indicated that health administrators (OR $=1.83\ (1.10,3.05); p = 0.021$), home quarantine (OR $= 2.16(1.32,3.55); p = 0.002$) were associated with a higher risk of poor sleep quality. Residents with the history of psychological and sleeping disorder such as insomnia (OR $= 2.03(1.43, 2.87); p < 0.001$), previous anxiety and depression(OR $= 1.67(1.15, 2.44); p = 0.007$) were more likely to have poor sleep quality. Current anxiety was a strong independent predictor of sleep disturbance. The OR in participants with mild anxiety was 3.28 with 95%CI (2.28,4.73), and that in moderate and severe anxiety group was 6.09 with 95%CI (2.06,17.98).

It is known that anxiety as an independent symptom, is not only one of the reasons of sleep disturbance but also shares many influence factors with sleep disturbance. Our multivariate logistic regression using the same variables above indicated female gender(OR $= 1.75$ $(1.20,2.54); p = 0.004$), home quarantine(OR $= 2.27(1.34,3.86); p = 0.002$), previous insomnia (OR $= 1.82(1.24,2.68); p = 0.002$) and previous anxiety/depression(OR $= 4.33(3.00,6.25); p < 0.001$) as predictors of current anxiety symptom during the resurge of COVID-19 in Beijing. Participants with age ≥55y are not likely to be anxious (OR$= 0.32(0.14,0.73), p = 0.006$).

Moreover, 793 (52.5%) participants were submitted to a nasopharyngeal swab for coronavirus, and reported no difference in sleep quality before-and-after the test. None of the participants reported having symptoms or testing positive for COVID-19.

4. Discussion

To the best of our knowledge, this is the first study investigating sleep quality and anxiety during the second wave of the COVID-19 pandemic. In the current study, the prevalence of sleep disturbance and anxiety was 49.2% and 12.2%, the former higher than reported in previous studies of the first wave (Wang et al., 2020; Huang and Zhao, 2020).It should be noted that our survey was conducted during the most serious period in the second wave and most of the participants are residents in Beijing. Emerging infectious diseases epidemics like Severe Acute Respiratory Syndrome (SARS), Ebola Virus Disease (EVD) tend to pose a negative impact on sleep quality (Moldofsky and Patcai, 2011; Wilson et al., 2018). With the virus largely under control in China, a new wave of Covid-19 cases could still increase the incidence of sleep disorders in residents. Besides, the effects of the epidemic on sleep and mental health did not have geographical restrictions; a majority (78.1%) of our participants resided near the second outbreak epicenter, and did not present with more sleep disturbances and anxiety than the residents in other areas of Beijing, similarly the residents who lived in other provinces reported no lower risk of poor sleep and anxiety than Beijing residents during the second wave. A previous large cross-sectional study reported postgraduate and students who lived in Hubei province, the center of the first outbreak, had a lower risk of anxiety and depression than undergraduates and students who lived in other provinces in China during the COVID-19 epidemic (Wang et al., 2020).

Compared with the first wave of pandemic at the beginning of 2020, residents had shorter sleep duration during the second wave. However, there was no significant difference between bedtimes during the two outbreaks. Sleep duration was a mediator between exposures and mental health problems. Non-epidemic factors such as seasonal variations have been taken into account, as the first outbreak occurred in winter while the second wave broke out in summer. Natural sleep duration is shorter in the summer (Yetish et al., 2015). However shorter sleep duration may aggravate self-reported poor sleep quality and mental problems (Raniti et al., 2016).

We explored the factors that could account for sleep disturbance during the second wave. We also observed that factors such as previous insomnia and anxiety-depression were significantly associated with sleep disturbance during the pandemic. Our results were consistent with previous studies in COVID-19 pandemic (Brooks et al., 2020; Cellini

et al., 2021; Hyun et al., 2021). Besides traditional factors, demographic characteristics, the effects of control measures are discussed. During the early outbreak, few residents had access to nucleic acid testing due to the limited availability of test kits. When Beijing's second outbreak took off, the city immediately ramped up its nucleic acid testing. City authorities conducted a staggering 2.3 million tests on residents in just 12 days (Guan and Biswas, 2020). More than half of participants (793, 52.5%) underwent nucleic acid testing, and all cases were negative. Overturning traditional assumptions, there has been no evidence showing that mass nucleic acid testing eases anxiety and improves quality of sleep. But participants home quarantined due to travel history to a high risk area were significantly more likely to report sleep disturbance and anxiety. Nationwide surveys conducted in the early stage of COVID-19 pandemic found higher prevalence of sleep problems among isolated populations (Wang et al., 2020; Yang et al., 2021) . Although quarantines were frequently effective in protecting the public from the spread of illness, we should weigh carefully the potential benefits of mandatory mass quarantine against the possible psychological costs.

However, unlike sleep disturbance and anxiety which are often related to fear of infection at the early stage of the outbreak (Yu et al., 2020), the present study found that people paid more attention to the collapsing revenues and occupational interference during the second wave of outbreak. Strong restrictive measures to control the pandemic have been impacted the global economy significantly, including rising unemployment and reducing income worldwide (Kawohl and Nordt, 2020), which could lead to sleep disturbance and depressive-anxiety disorders (Fu et al., 2013). Interestingly, people from different occupations had similar prevalence of sleep disturbance and anxiety symptoms, including careers deeply affected by COVID-19. In the current study, medical workers (44.2%) did not report more severe sleep disturbance. Due to China's successful control of COVID-19, the healthcare system does not seem to be overwhelmed. There have been no infections reported in medical staff during the second outbreak in Beijing, which greatly relieved anxiety and stress for healthcare workers. Besides during the second wave in Beijing, in order to prevent further spreading of COVID-19, walk-in patients had to make hospital appointments in advance. The number of hospital patients deceased than before. The workload of most non-frontline healthcare workers had been significantly reduced. Deeper cognition of COVID-19 and higher educational level in medical staff also seem to have a protective effect against anxiety and depression (Bjelland et al., 2008).

Anxiety is an important reason for the occurrence of sleep disorders, and also an independent symptom. It has many of the same influencing factors as sleep disorders, so we also analyzed the influencing factors for the occurrence of anxiety state in the second epidemic. After multivariate logistic regression analyses, we found that in addition to home quarantine and pre-existing insomnia, anxiety-depression symptoms appear to be significant predictors to sleep disturbance and anxiety symptoms; women and people aged under 55 years were independent predictors for anxiety. Previous studies reported females were more likely to have anxiety than men in during the SARS and COVID-19 epidemic (Gao et al., 2020; Guo et al., 2016; Hawes et al., 2021). Two recent web-based cross-sectional studies also demonstrated that younger subjects were at high risk of psychological problems, such as general anxiety disorder and suicidal thoughts during the COVID-19 pandemic (Huang and Zhao, 2020; Li et al., 2020).

This study has several limitations. First, a cross-sectional study design during the acute pandemic stage limited the ability to determine the causal inference. The reliability of retrospective data of sleep during the early outbreak is likely to be reduced by factors such as memory loss and errors in recall. The prospective study with follow up at different stages of the pandemic can help us better understand the sleep mental health response and multi-dimensional factors. Second, online survey is a useful tool for evaluating how the general public understands and perceives a fast-moving infectious disease outbreak, however the

possibility of selection bias such as occupation and age should be considered. In this study, the medical staff participants constituted a relatively high proportion, causing a deviation towards a higher degree in education. Further studies with multiple recruiting sources including traditional paper questionnaires may broaden subject participation.

5. Conclusion

This nationwide cross-sectional survey research showed poor sleep quality and anxiety are common during the second wave of COVID-19 crisis in Beijing. Residents who were home quarantined and had a previous history of insomnia and anxiety-depressive tended to have a higher risk of sleep disturbance and anxiety. Age and gender were an impacting predictors of anxiety. Prevention and control measures such as nucleic acid testing did not increase sleep disorders and anxiety.

With the increasing experience of fighting COVID-19 and mass coronavirus vaccination, we expect to bring COVID-19 under control eventually. However, the fight is still far from over, this winter a surge in COVID-19 cases occurred in China, while the numbers continue to climb worldwide. This study may provide valuable reference to similar reemergence of the virus elsewhere in the future. It is essential to develop proper measures for mental health assessment, support, and intervention in order to reduce the negative psychological symptoms of poor sleep and anxiety for the targeted population to improve the mental health both during and after the COVID- 19 pandemic.

CRediT authorship contribution statement

Yanan Liu: Conceptualization, Visualization, Writing – review & editing. **Xi Wang:** Writing – review & editing. **Pengfei Sun:** Formal analysis. **Qi Zhang:** Writing – review & editing. **Cheng Zhang:** Investigation, Resources. **Yane Shen:** Investigation, Resources. **Shixuan Wang:** Investigation. **Jing Ma:** Visualization, Writing – review & editing, Supervision. **Guangfa Wang:** Supervision.

Declaration of Competing Interest

The authors do not have any conflict of interest to report.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2021.10.068.

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