ORIGINAL RESEARCH

Prevalence and Risk Factors Associated with Insomnia Symptoms Among the Chinese General Public After the Coronavirus Disease 2019 Epidemic Was Initially Controlled

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Introduction: The prevalence rate and related factors of insomnia remained unknown after the COVID-19 epidemic had been under control. Therefore, we conducted this survey to investigate the prevalence rate and related factors of insomnia symptoms in the Chinese general public after the COVID-19 had been initially control.

Methods: An online survey was conducted among Chinese citizens through the JD Health APP. The questionnaire was used for collecting demographic data and self-designed questions related to the COVID-19 outbreak. Insomnia Severity Index, Patient Health Questionnaire-9, Somatic Symptom Scale-8 and Impact of Events Scale-Revised were used for measuring psychological symptoms. To examine the associations of sociodemographic and psychological factors with insomnia symptoms, a binary logistic regression was used.

Results: In total, there were 14,894 eligible participants, and 4601 (30.9%) participants were found to have insomnia symptoms. The regression model revealed that a higher risk of insomnia symptoms was associated with being over the age of 40 years, having history of psychiatric disorders, smoking, having infected friends or colleagues, having depressive or somatic symptoms, experiencing psychological distress and feeling estranged from family members. Meanwhile a lower risk of insomnia symptoms was associated with being female, having closer family relationships, not feeling alienated from others and being satisfied with the available information.

Conclusion: In our study, 30.9% of the participants in the general public reported insomnia symptoms after the COVID-19 epidemic had been initially controlled. When providing precise interventions for insomnia, extra attention should be paid to the individuals who are male, elderly and smokers, and those with psychiatric disorder history, with infected friends or colleagues, with psychological symptoms and with poor social support.

Keywords: insomnia symptoms, prevalence, COVID-19, under control, general public, China

Introduction

In December 2019, the novel coronavirus (COVID-19) first broke out in Wuhan, China, causing grave concern among the public.[1] To prevent the broader spread of the disease, the Chinese government decided to restrict all the outbound and inbound channels, first in Hubei Province and later in the entire country.[2] This preventative action had a remarkable effect, which could be reflected by the fact

that there have been no more confirmed cases among local residents since May 24th.[3] Within the succeeding 18 days, only one new indigenous confirmed case was reported (on June 6th).[4] It was the first time there had been so few new indigenous confirmed cases for so long- even longer than the 2-week incubation of COVID-19. Therefore, it can be stated that the COVID-19 epidemic had been initially controlled in Mainland China in those 18 days. However, a tendency towards the COVID-19 epidemic resurgence started to show up since June 11th.[5]

COVID-19 caused concern as well as great psychological problems in both regular citizens and healthcare workers. Depression, anxiety, insomnia and acute stress symptoms were all found to be more prevalent among the public during the outbreak.[6] More severe symptoms of these mental health problems occurred among the patients confirmed or suspected of having COVID-19, the people with confirmed or suspected family members and friends, and the residents of Hubei Province.[6] Quarantine and delays to return to work were also found to be associated with mental health status.[6] Another study showed that the prevalence of somatic symptoms also increased in the general population at the peak of the epidemic period compared to the beginning of the outbreak, which was thought to be related to psychological resilience.[7] In addition, a high prevalence of sleep problems were observed among the adolescents whose anxiety and depression symptoms were proved to be mediators of social support and insomnia symptoms.[8] Furthermore, a systematic review and meta-analysis suggested that a considerable proportion of healthcare workers experienced mood and sleep disturbances during this outbreak.[9] Regarding the factors related to insomnia in healthcare workers, Zhang's study found that insomnia symptoms were associated with education level, isolated environment, the psychological worries about the COVID-19 outbreak, and doctor occupation.[10] In regard to the period after the COVID-19 pandemic had been controlled, a longitudinal study showed that fear significantly decreased while depression levels significantly increased over the course of the pandemic.[11] However, a contradictory result was reported in another study investigating perinatal women, which showed a decrease in the prevalence of depression, anxiety and insomnia symptoms.[12]

Although several studies have analyzed the psychological health status in China during the COVID-19 epidemic, most of them focused on each particular population, such as healthcare workers, adolescents and perinatal women. In addition, only few studies have investigated the public mental health situation after the COVID-19 epidemic had been under control rather than the outbreak time. Lastly, to the best of our knowledge, no studies have investigated insomnia after the COVID-19 epidemic had been under control. In view of this gap in knowledge, we conducted this large-sample study to assess insomnia symptoms and to explore the related social psychological factors of insomnia symptoms in the Chinese general public after the epidemic had been initially controlled.

Methods
Study Design and Samples
The survey was cross-sectional and was conducted online among Chinese citizens, using the convenience sampling method. It was launched on June 5th, 2020, after the COVID-19 epidemic had been controlled in all of Mainland China for nearly 2 weeks, and it ended on June 7th, 2020. The survey link was posted on JD Health APP, a large e-commerce and information service platform that has over 70 million users and provides online health products and services in China. All the APP users can obtain access to the survey, but each account can only submit the survey once. Before it started, the purpose and significance of the survey were briefly introduced to all participants, and participant consent was required to continue. The survey was allowed to proceed only if all the questions were answered before the final submission, and then the data were recorded and stored on the APP automatically. A string would be generated and recorded automatically by the APP system to replace each user's name, ensuring confidentiality in the further data handling. Participants who met the following criteria were qualified: (1) could read a questionnaire written in Chinese, (2) JD Health APP users, and (3) volunteered for the survey. The exclusion criteria consisted of (1) being unable to understand the questionnaire and (2) being under 18 years old. The study was approved by the Ethics Committee of Nanfang Hospital of Southern Medical University. To guarantee the respondents' privacy, the survey was conducted anonymously. The study was conducted in accordance with the Declaration of Helsinki.

Measures
Demographic data were collected. Self-designed questions related to the impact of COVID-19 epidemic, such as

infection status, the perceived feelings on changes of relationship and satisfaction of available information, were asked in the survey. We also administered the Insomnia Severity Index, the Patient Health Questionnaire-9, the Somatic Symptom Scale-8, and the Impact of Events Scale-Revised.

To detect the symptoms and cases of insomnia, the Insomnia Severity Index (ISI) was used. ISI is a reliable and valid instrument to quantify perceived insomnia severity.[13] The total scores of ISI ranges from 0 to 28, with each item rated on a 0–4 scale. Higher scores indicate more severe insomnia symptoms.[14] The score of ≥8 is considered to indicate symptoms of insomnia.[15]

The Patient Health Questionnaire-9 (PHQ-9) was included to assess depressive symptoms. The total score can be categorized into five severity levels: normal (0–4), mild depression (5–9), moderate depression (10–14), moderate to severe depression (15–19) and severe depression (20–27).[16,17] Previous study had proved a great reliability and validity of the PHQ-9 among the Chinese general population.[17]

For the evaluation of psychological distress in response to COVID-19, the Impact of Events Scale-Revised (IES-R) was performed.[18] It is a five-point Likert scale for which the total scores can be categorized into four different levels: subclinical (0–8), mild (9–25), moderate (26–43) and severe (44–88). The great reliability and validity were observed in the Chinese version of IES-R.[19]

The Somatic Symptom Scale–8 (SSS-8), composed of 8 items, was used for assessing the somatic symptom burden over the past 7 days. The sum of the scores ranges from 0 to 32, which can be categorized into five different levels: none to minimal (0–3), low (4–7), medium (8–11), high (12–15) or very high (16–32) physical symptoms.[20] Matsudaira's study had confirmed the validity and internal consistency of SSS-8.[21]

Statistical Analysis

The categorical variables are presented as frequencies and percentages. Descriptive statistical analyses were performed by using the Chi-square test. Post-hoc analyses were performed on multiple category data by *Bonferroni* correction. To examine the associations among the demographic factors, epidemic-related factors and psychological factors with insomnia symptoms, a binary logistic regression was used. The regression model was adjusted for gender and age by using the enter method while other factors were analyzed by using the forward likelihood

ratio method. The sensitivity analyses were conducted to determine the influence of the different cut-off score on the findings.[15,22] All the analyses were two-tailed with an alpha level set at $P < 0.05$ and were conducted by using SPSS Analytics software v.22.0.

Results

Characteristics of the Subjects and Prevalence of Insomnia Symptoms

A total sample of 14,999 participants was finally obtained, and 105 (0.7%) of the initial respondents were excluded prior to the data analysis since their age was under 18. Tables 1 and 2 show the characteristics of the eligible participants and the differences between the insomnia symptom and non-insomnia symptom groups in terms of demographic data, COVID-19 epidemic-related questions and psychological status. Based on their ISI score (ISI ≥8), 4601 participants (30.9%) were found to have symptoms of insomnia. In addition, 6277 (42.1%) participants, 6501 (43.6%) participants and 8635 (58%) participants were found to have depressive symptoms (PHQ-9 ≥5), somatic symptoms (SSS-8 ≥4) and psychological distress (ISE-R≥9), respectively. The sensitivity analyses showed that the results obtained by using the cut-off scores of ≥8 were roughly consistent with that by using the cut-off scores of ≥10. (Shown in STables 1 and 2 in Supplement)

The participants with insomnia symptoms (ISI ≥8) were likely to be in the 18-to-40-year-old age range, be of minority ethnicity, have bachelor's degree or above, live in Wuhan, have medical history of psychiatric disorders, drink alcohol at least 2 times per week, smoke, be confirmed to have been infected with COVID-19, have infected friends or colleagues, become estranged from their family, feel alienated from others, be dissatisfied with the available information, have somatic symptoms, have depressive symptoms and experience psychological distress when compared with those without insomnia symptoms. However, female participants displayed a lower risk for insomnia symptoms. (Shown in Tables 1 and 2) The results of the unadjusted regression analysis of the related variables are presented in STable 3 in the Supplement.

Factors Associated with Symptoms of Insomnia

The results of the binary logistic regression analysis on insomnia symptom-related factors are shown in Table 3. Female participants were found to have a lower risk of

Table 1 Comparisons Between Insomnia Symptoms and Non-Insomnia Symptoms Individuals on Demographic Data. (N=14,894)

	Insomnia Symptoms (n=4601)	Non-Insomnia Symptoms (n=10,293)	χ^2	P
Gender			43.893	<0.001
Male	2152(46.8%)	4216(41.0%)		
Female	2449(53.2%)	6077(59.0%)		
Ethnicity			7.491	0.006
Han	4371(95.0%)	9880(96.0%)		
Minority	230(5.0%)	413(4.0%)		
Age (years old)			10.535	0.001
18~40	3173(69.0%)	6820(66.3%)		
>40	1428(31.0%)	3473(33.7%)		
Education level			18.308	<0.001
High School or below	981(21.3%)	2526(24.5%)		
Bachelor or above	3620(78.7%)	7767(75.5%)		
Cities lived in the past month			19.843	<0.001
Wuhan*	171(3.7%)	251(2.4%)		
Cities in Hubei Province except Wuhan*	678(14.7%)	1473(14.3%)		
Cities outside of Hubei Province*	3752(81.5%)	8569(83.3%)		
Medical history			849.923	<0.001
None*	3833(83.3%)	9863(95.8%)		
Physical diseases*	228(5.0%)	292(2.8%)		
Psychiatric disorders*	540(11.7%)	138(1.3%)		
Alcohol use			190.850	<0.001
Never*	2508(54.5%)	6826(66.3%)		
Less than 1 time per week*	1828(39.7%)	3063 (29.8%)		
At least 2 times per week*	265(5.8%)	404(3.9%)		
Smoking			103.334	<0.001
No	3750(81.5%)	9036(87.8%)		
Yes	851(18.5%)	1257(12.2%)		

Notes: *Significant after Bonferroni correction.

insomnia symptoms than male participants (adjusted OR 0.80, 95% CI 0.72–0.88). Compared with the participants aged 18 to 40 years old, those over 40 years old demonstrated a higher risk of insomnia symptoms (adjusted OR 1.16, 95% CI 1.05–1.28). The participants with medical history of psychiatric disorders also showed a higher risk of insomnia symptoms than those without any medical history (adjusted OR 3.10, 95% CI 2.46–3.90). Besides, the participants who smoked had a higher risk than non-smokers (adjusted OR 1.41, 95% CI 1.22–1.61). In addition, an elevated risk for symptoms of insomnia was found in the participants with depressive symptoms (adjusted OR 5.35, 95% CI 4.83–5.93), somatic symptoms (adjusted OR 3.43, 95% CI 3.11–3.78) and psychological distress (adjusted OR 3.24, 95% CI 2.89–3.63). Having infected

friends or colleagues and feeling estranged from family members were also found to be other risk factors (adjusted ORs 1.70 [95% CI 1.17–2.46] vs 1.46 [95% CI 1.17–1.82]). Nonetheless, a lower risk of insomnia symptoms was associated with having closer family relationships (adjusted OR 0.87, 95% CI 0.79–0.95), not feeling alienated from others (adjusted OR 0.79, 95% CI 0.71–0.87) and being satisfied with the available information (adjusted OR 0.69, 95% CI 0.63–0.76).

Discussion

To the best of our knowledge, this is the first study to investigate insomnia symptoms in the general public after the COVID-19 had been initially controlled. Among the large sample of 14,894 valid participants, 30.9% suffered

Table 2 Comparisons Between Insomnia Symptoms and Non-Insomnia Symptoms Individuals on COVID-19 Related Data and Psychological Status. (N=14,894)

	Insomnia Symptoms (n=4601)	Non-Insomnia Symptoms (n=10,293)	χ^2	P
COVID-19 epidemic-related questions				
Suspected or confirmed infected with COVID-19			221.920	<0.001
None*	4357(94.7%)	10,169(98.8%)		
Suspected*	229(5.0%)	118(1.1%)		
Confirmed*	15(0.3%)	6(0.1%)		
Anyone around confirmed infected with COVID-19			362.872	<0.001
None*	4003(87.0%)	9794(95.2%)		
Families*	94(2.0%)	73(0.7%)		
Friends or colleagues*	178(3.9%)	67(0.7%)		
Neighborhood or communities*	326(7.1%)	359(3.5%)		
Family relationship			297.654	<0.001
Became estranged*	355(7.7%)	238(2.3%)		
Not changed*	2541(55.2%)	5332(51.8%)		
Became closer*	1705(37.1%)	4723(45.9%)		
Feeling alienated from others			704.929	<0.001
Yes	783(17.0%)	826(8.0%)		
Neutral*	1829(39.8%)	2697(26.2%)		
No*	1989(43.2%)	6770(65.8%)		
Satisfaction of available information			472.453	<0.001
Dissatisfied*	500(10.9%)	668(6.5%)		
Neutral*	2222(48.3%)	3457(33.6%)		
Satisfied*	1879(40.8%)	6168(59.9%)		
Psychological Status				
Having somatic symptoms (SSS-8)			3333.841	<0.001
No (0~3)	978(21.3%)	7415(72.0%)		
Yes (4~32)	3623(78.7%)	2878(28.0%)		
Having depressive symptoms (PHQ-9)			4461.961	<0.001
No (0~4)	802(17.4%)	7815(75.9%)		
Yes (5~27)	3799(82.6%)	2478(24.1%)		
Having psychological distress (IES-R)			2470.788	<0.001
No (0~8)	550(12.0%)	5709(55.5%)		
Yes (9~88)	4051(88.0%)	4584(44.5%)		

Notes: *Significant after Bonferroni correction.
Abbreviations: SSS-8, Somatic Symptom Scale-8; PHQ-9, Patient Health Questionnaire-9; IES-R, Impact of Events Scale-Revised.

from insomnia symptoms. More psychological problems related to COVID-19 appeared in those with insomnia symptoms. Being male, being older, having medical history of psychiatric disorders, smoking, having somatic symptoms, having depressive symptoms and experiencing psychological distress were all found to be risk factors for insomnia symptoms, while having closer relationships with family, not feeling alienated from others and being satisfied with information about COVID-19 were protective factors.

The prevalence of insomnia symptoms during the remission period was 30.9% in our study, which is higher than 15.0% during normal times and 20.05% at the beginning of the COVID-19 outbreak.[23,24] The prevalence rate

Table 3 Binary Logistic Regression Analysis of Insomnia Symptoms-Related Factors

	OR	P	95% C.I
Demographic factors			
Gender (ref: Male)			
Female	0.80	0.000	0.72–0.88
Age (ref:18–40)			
>40	1.16	0.004	1.05–1.28
Medical History (ref: None)			
Physical diseases	1.18	0.162	0.94–1.47
Psychiatric disorders	3.10	0.000	2.46–3.90
Smoking (ref: No)			
Yes	1.41	0.000	1.22–1.61
COVID-19 epidemic-related factors			
Anyone around confirmed infected with COVID-19 (ref: None)			
Families	1.30	0.196	0.87–1.95
Friends or colleagues	1.70	0.005	1.17–2.46
Neighborhood or communities	1.11	0.322	0.91–1.35
Family relationship (ref: Neutral)			
Became estranged	1.46	0.001	1.17–1.82
Became closer	0.87	0.003	0.79–0.95
Feeling alienated from others (ref: Neutral)			
Yes	1.01	0.907	0.87–1.17
No	0.79	0.000	0.71–0.87
Satisfaction of available information (ref: Neutral)			
Dissatisfied	1.03	0.722	0.87–1.22
Satisfied	0.69	0.000	0.63–0.76
Psychological factors			
Having somatic symptoms (ref: No)			
Yes	3.43	0.000	3.11–3.78
Having depressive symptoms (ref: No)			
Yes	5.35	0.000	4.83–5.93
Having psychological distress (ref: No)			
Yes	3.24	0.000	2.89–3.63

in our study was consistent with 29.2% among the Chinese general public during the pandemic period in another study, using the same measurement and cut-off.[6] However, it is much higher than 13.9% in another study conducted after the epidemic had been controlled, which may be due to the different measurements used in the two studies.[12] The higher prevalence of our finding shows that insomnia symptoms occurred along with the outbreak of COVID-19 and continued to present even after the epidemic had been under control. This finding might indicate that insomnia symptoms tended to become chronic during the whole epidemic period. Many reasons can account for this finding, among which stress is usually considered the primary one.[25] The mechanism underlying this insomnia involves stress activating the hypothalamo-pituitary-adrenocortical (HPA) systems, which is incompatible with normal sleep, and the resulting sleep impairment causes further increases in the HPA system. This last effect promotes a vicious circle of stress and insomnia.[26] The primary source of stress in this study was clearly derived

from the COVID-19 epidemic. According to this finding, the trend in insomnia symptoms becoming chronic may warn us that the stress from COVID-19 lasted from the epidemic outbreak period to the period that the epidemic had been controlled. Thus, understanding and dealing with the stress from COVID-19 may be still necessary for effectively treating insomnia symptoms even after the epidemic had been controlled.

Some demographic factors were found to be associated with insomnia symptoms. Our study surprisingly found that female individuals were less likely to have insomnia symptoms than males, which is contrary to most previous studies.[27–29] However, the trend we found was consistent with the result of a recent study conducted during the COVID-19 outbreak period.[6] One of the reasons may be attributable to the more frequent risky behaviors during epidemics and a higher infective rate among males.[6] Another reason was that male had poorer knowledge about COVID-19 than female,[30] resulting in their fear and worry about COVID-19 and hyperarousal. In line with previous studies, the rate of insomnia symptoms rose with age, and insomnia symptoms were more likely to occur in elderly individuals.[31,32] The participants aged over 40 in our study suffered more symptoms of insomnia than the youth aged 18 to 40. This phenomenon can be explained by the significant physiological changes in sleep and circadian rhythm across the lifespan.[33] In addition, stressful life events or medical conditions, such as respiratory symptoms, physical disability and poor perceived health, also place older adults in an increased risk of insomnia.[33] Besides, the smokers in our study had a higher risk of insomnia symptoms than nonsmokers, which is the same as previous findings.[34,35] The mechanism is diverse, but the most important mechanism is related to nicotine. This active ingredient is a stimulant that increases alertness, so using it too close to bedtime may affect sleep latency.[36] Furthermore, nicotine was believed to increase the risk for snoring and obstructive sleep apnea, ultimately leading to insomnia symptoms.[37]

Another fact we need to note is that depressive symptoms, somatic symptoms and psychological distress were three important factors that were significantly associated with insomnia symptoms. The same results were observed in a study concerning adolescents.[8] The medical history of psychiatric disorders was also found to be a risk factor. This finding is reasonable since insomnia can become secondary to psychiatric disorders or psychological problems, while insomnia may either arouse psychiatric or psychological symptoms. Ohayon has shown that a previous history of a mental disorder is closely related to the severity and chronicity of current insomnia.[38] Another study done by Have verified that insomnia was a prevalent problem across different categories of mental disorders, even during the remitted phase.[39] Therefore, when intervening in insomnia in the general public, the people with history of mental illness may deserve more attention. It would be necessary to address psychiatric or psychological symptoms to cope with a patient's insomnia symptoms, although we should reduce their stress at the same time.

As expected, our study showed that the people with better social support (including the support from families and friends) or psychological support (including the satisfaction regarding available information) were at a lower risk of developing symptoms of insomnia. The same evidence was noted by Roberts et al In their study, more severe insomnia at baseline significantly predicted worse parental relationships, lower perceived social support, and more problems with peers one year later.[40] Social support is an important resource linked to one's mental well-being. The people who frequently experience stressful events in their daily life benefit from social support because it contributes to an individual's capability to cope with negative life experiences and to mitigate the negative impact of stress.[41] In other words, ineffective social support may lead to more stress and ultimately result in insomnia.

In summary, understanding the factors associated with insomnia symptoms could help to provide precise interventions for insomnia in the public. Extra attention should be paid to the people who are male, elderly, and smokers and those with history of a psychiatric disorder. Moreover, maintaining proper interpersonal relationships and improving satisfaction with the available information may help to reduce the risk of insomnia. To accomplish more effective interventions for insomnia, there are some actions that might be emphasized. On the one hand, medical services should be redistributed to ensure the timely treatment for mental health problems, since patients with mental disorders could not receive timely diagnoses, treatment or routine psychiatric care because of the suspended hospital visits during the outbreak period.[42] On the other hand, online mental health services, such as hotlines and mobile application platforms, are recommended to be adopted more widely considering the traffic limits and quarantine measures in many areas.[43]

The strengths of this study are its wide coverage among the Chinese citizens, enormous sample size and special study period. The participants were recruited from different places with multi-demographic and COVID-19 epidemic-related characteristics. Furthermore, to the best of our knowledge, this is the first study conducted to investigate the prevalence of and factors associated with insomnia symptoms systematically after COVID-19 had been initially controlled. We observed that insomnia symptoms among the general public might have trended towards becoming chronic during the entire epidemic period. Our results and findings may be helpful to make political or medical decisions during this new period of the COVID-19 epidemic.

Our study has several limitations. First, this survey was completed online using a convenience sampling method. Only people having logging into their accounts on the JD Health APP could take part in the survey, meaning that the people being less technology literate may not be able to attend the survey. Therefore, the representativeness and the generalizability of the findings might be limited due to the restriction of entering the survey and its sampling method, although this study was geographically extensive and had a large sample size. Second, the total quantity of the APP users having opened the survey link was not recorded in our study, leaving the response rate unknown. Third, all the demographic data or mental health symptoms in the survey were self-reported, which may lead to some bias. Fourth, this was a cross-sectional study, so the associations between mental health symptoms and risk factors could not be considered as causal relationships. Finally, our findings suggested the possibility that insomnia symptoms tended to become chronic. However, further studies, especially follow-up studies, are required to draw these conclusions.

Conclusion

In our study, 30.9% of participants in the Chinese general public reported insomnia symptoms after the COVID-19 epidemic had been initially controlled. When providing precise interventions for insomnia, extra attention should be paid to the individuals who are male, elderly, and smokers and those with psychiatric disorder history, with friends or colleagues infected, with psychological symptoms and with poor social support.

Abbreviations

COVID-19, Corona Virus Disease 2019; ISI, Insomnia Severity Index; PHQ-9, Patient Health Questionnaire-9; SSS-8, Somatic Symptom Scale-8; IES-R, Impact of Events Scale-Revised.

Disclosure

The authors report no conflicts of interest in this work.

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